CHIMNEY CONSTRUCTION*

BY R. M. AND F. J. BANCROFT.

In designing and building a chimney shaft, apart from the local considerations there are always certain rules, etc., which have been determined by experience. Some of these are as follows:

Foundations.—In building large chimneys one of the most important subjects is the construction of the foundations. Very much will depend upon the nature of the ground. At Halifax and neighborhood it often occurs that the solid rock is reached a few feet below the ground line. Here it is only necessary to excavate to such a depth that the heat of the gases will not materially affect the natural stone, and to a depth sufficient to allow the necessary spreading of the base. In many instances, however, chimney stacks have to be built near rivers and on sites where the upper strata is of alluvial clay or made ground, and it is necessary to carry the foundations deep down until a stiff clay, hard sand, or rock bottom is reached. This frequently entails excavation 25 or 30 feet deep, or even more, and it is only necessary that the foundation should be large enough to carry the superincumbent weight, but also that it should be in such an area that it will not allow the base to be forced into the yielding ground. This deep foundation is usually constructed of concrete. In some cases piles are driven in to form the foundation, as instanced, among others, in a brick chimney erected at Boston, and an iron chimney constructed at Ohio, (?)U. S.A. This is a measure of which the engineer must decide the advisability, their great aid being to economize material, without risking unequal subsidence, which cannot be too carefully guarded against. In fact, it is the practice in the erection of tall stacks to construct the foundation and pedestal, if any, and allow them to stand some considerable time before proceeding with the shaft proper, in order that the work may set, and any slight settling may take place before a great weight is placed upon them.

As a remarkable instance of the general settling of the foundation of a shaft, we may mention a chimney which was built by Mr. Clegg at Fulham in 1829. The foundation was a quicksand in which an iron rod sank to a depth of 15 feet with little more than its own weight as pressure. During erection the concrete foundation sank bodily 16½ inches without cracking the shaft or causing it to deviate from the perpendicular. From this it will naturally follow that in all cases the ground at the foundation should offer equal resistance, or unequal settling will take place, as in the case of the Newlands Mill chimney at Bradford, mentioned further on in this paper. Some of the pressures exerted upon the foundations are given under the respective descriptions of chimneys.

Copings and Cornices.—The stone coping or cornice of a chimney will seldom require more to hold it together than two good cramps across each joint. These should be of copper or double dovetailed slate dowels; on no account use iron, as it will oxidise and burst the stone.

Caps.—Heavy and large caps are often the source of great danger, inconvenience, and expense, as the cap at the top in a gale of wind acts upon the shaft as a weight at the end of a long lever. This was the case at Messrs. Brooks and Sons' Fireclay Works, Huddersfield, as mentioned further on.

Wind Pressure.—It is usual in this country to estimate as the maximum pressure 55lb. per square foot, but as in 1868 the pressure of wind at Liverpool was registered at nearly 80lb. per square foot, it is advisable to take a higher factor.

Height and Dimensions.—It has been stated by good authorities that the height of chimneys should never be more than ten or twelve times the width of the base above the ground, and the top not wider than two-thirds of the base. There appears, however, to be a wide difference of opinion on this subject. Mr. Robert Armstrong in the appendix to his "Chimneys, Furnaces, and Fireplaces," published by Spon in 1866, page 63, says: "It may be set down as an axiom that *a steam engine chimney cannot be too large*, if only provided with a damper, although ninety-nine in one hundred at the present time (1866) are decidedly too small. They are unable to create a sufficient draught of air through the furnace, consequently a smoky flue is produced, instead of a flame with little or no smoke." Against Mr. Armstrong's opinion we learn from Mr. Peter Carmichael, in his paper on "Factory Chimneys," read before the Institution of Engineers in Scotland (1865) that his "experience is that most factory chimneys are too large for the work they have to do; not too high (they can hardly be that), but too wide, especially at the top. In our practice (Messrs. Baxter Bros. Flax Mills, Dundee) invariably as more boilers and furnaces have been added to a chimney the draught has been improved, and it is obvious that if the opening in the chimney be too large, compared with the whole of the openings in the dampers passing into it, the draught will be reduced. Hence it is very noticeable in many chimneys which are large in proportion to the number of furnaces they serve, or the coals consumed, or when a new chimney is put up to serve for prospective additional furnaces, the smoke issuing from such has a very lofty ascent, and they are generally blackened a long way down from the top by the smoke, for when a breeze is blowing the smoke, instead of ascending, falls down the leeward side of the chimney, and clings to it like a ragged black flag."

Mr. Robert Wilson, in his "Boiler and Factory Chimneys," published by Crosby, Lockwood, and Co., in 1877, cautions us against too large a flue. He says:—"It is usually considered that the larger the area of the chimney the better the draught, but this is not always the case with lofty chimneys where the gasses can cool down too rapidly in a chimney of large section, and it has been found in several instances that when chimneys are very large for the number of boilers they serve, or for the quantity of coals burnt, as when a chimney is built to serve for future additions to the boiler power, the draught is improved by the better maintenance of temp rature as additional boilers are set to work) thus agreeing almost word for word with Mr. Peter Carmichael.) When the area of the chimney is much larger than the aggregate area of the flues debouching upon it, the diminution of friction and the expansion of the hot gases into a large area are favorable for the improvement of the draught. But the velocity of the ascent of the heated gases may be very much diminished, and, in extreme cases, where the ascending current does not fill the chimney, so to speak, downward currents of air will be produced, especially with the wind in certain directions, to the impairment of the draught."

Temperature of Escaping Gases.—Mr Peter Carmichael recorded observations made from time to time for several years on the temperature of the escaping products of combustion in the flues and at the bottom of the chimneys, and also took notice of the force of the draught, both of which are important elements in considering the value of a chimney in doing its work properly, and he gives the results as follows:—"The temperature is obtained by using small strips of the following metals:—Zinc, which melt at 700deg.; Lead, 600deg.; Bismuth, 500deg., and Tin 440deg. Small bits of each of these, about one inch long and quarter-inch broad, are pierced with a hole for passing a wire through, and suspended in the flues behind the damper, or at the bottom of the chimney, and the time noted when they are melted. From these observations, frequently repeated and tried under various circumstances, it has been found that the temperature is nearly uniform at 600deg. behind the dampers; 440deg. melts at once, 500deg. generally in less than a minute, 600deg. melts when the fires are in a good condition, and 700deg. does not melt. So unvarying are these results under different circumstances that I assume 600deg. at the bottom of our chimneys as a standard of temperature of escaping products."

Details of Various Shafts.—We now give details of various shafts that have been erected at different dates:—The first is a chimney shaft built from the designs and under the superintendence of Mr. W. H. Wheeler, C. E., borough surveyor, Boston, Lincolnshire. The height from floor line of mill to top of cap is 105ft. 3in. It cost about £350. There are about 16 rods of brickwork in it (it is not measured solid) and about 740ft. cube of Bramley Fall stone. The iron cap at the top is 4ft. 6in. diameter, 9in. wide, 9in. deep on inside, and 3in. deep on outside, 1in. thick, with flanges and bolts. The chimney is built on piles, nine in number. The shoes of the piles are 30ft. below the floor line of the mill. The upper part of the soil is silty clay, and the lowest part hard clay and chalk stones.

On the Royal Porcelain Works at Worcester there are three large stacks, viz.: first, octagonal about 100ft. high, with a fine ornamental top in brickwork. This chimney, owing to the foundation giving away, was, in 1866, 2ft. 4in. out of the perpendicular, but in that year it was set upright by a piece being sawn out of one side at the base. The second is a chimney erected 1866. The base is 15ft. square. It is carried up square for 30ft., then in an octagon shape, and finally in a circular form to the height of 171ft. Forty feet of the shaft is 10in. in thickness, being composed of double bricks, while the remainder is of single bricks 13in. by 5½in., with a groove in the centre. The stack is screwed down with eight iron pins, and there are iron rings and supports every 12ft. The cornice is made of brick, and the whole is surmounted by an iron cap over two tons in weight. At the time this chimney was built only one other had been erected on the same principle, namely, at Buckley Morton in North Wales, but that one is not so high. The third is about 180 feet high, and 48 feet in diameter at the base. It is built in a square form, and has no pretensions to ornament.

The retort house shaft at the South Metropolitan Gas Works, Old Kent Road, London, S. E., cost £350. Its total height above the ground line is 108ft., and depth from the bottom of the concrete foundation 9ft. 9in. The flue is 5ft. square and parallel throughout its length. Eighty thousand bricks were used in building it. The weight of the cast-iron cap is two tons. The interior of the flue is built with fire bricks throughout its height, the fire bricks being built in with the stock bricks in old English bond of alternate layers of headers and stretchers, so that the courses of fire bricks are alternately 9in. and 4½in. thick. They were specially obtained for this chimney of the same size as the stock bricks. The retort house shaft, erected in 1862, has been in work ever since, and has not been burnt away at all; the fact is the heat of a chimney is not sufficient to injure good fire bricks. Fire bricks are usually thinner than stocks, and Mr. Livesey sometimes adopts the plan of bonding them into the stocks every sixth or eighth course where the courses coincide. In a similar chimney shaft, 70ft. high, recently erected entirely of fire bricks for the new engine house at these gas works, Mr. Livesey carried up the 14in. work about 50ft., and then reduced it to 9in. work to the top by a set-off inside, so that the flue is larger at the top than the bottom.

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A chimney shaft at Woolwich Arsenal has the following dimensions. The height from the concrete foundation to the top is 239ft. 9in., and from the ground to the top 223ft. 9in. The base above the ground line is 20ft square, The plinth and cornice stand 27ft. high, above which the octagonal shaft commences. Its diameter at bottom is 16ft. 9in., with 2ft. 7½in. walls, and at top 6ft. 6in., with 9in. walls. The brickwork is reduced 4½in. at every 31ft 6in., the topmost length being 26ft. It is all built in mortar, except the top 9ft. which is bell-shaped and built in cement, and it is finished with a Portland stone cap and blocking weighing about 17 tons. The time occupied in building from the laying of the first brick to the laying of the last stone at the top was 19 weeks.

The height of the circular chimney stack at Adam's Soap Works, Smethwick, near Birmingham, was, when first built, 326ft. 10in., measuring from the bottom of the foundation to the top, the height from the ground surface being 312ft. The outside diameter at the ground was 27ft. 2in., and the inside diameter was 15ft. 2in. At the top its outside diameter was 5ft. 6in., and inside 4ft. The weight of the brickwork was 2,000 tons, and of the concrete, sand, and lime 150 tons. This chimney was built in 1835, and at the time of its erection was the highest in the kingdom. The builder who began it felt alarmed when about half way through his work, and the firm had to finish it themselves. It has been five times struck by lightning, once during the building, and four times since. No very serious damage was done to it by the lightning but once, when—perhaps from this cause and the abstraction of the lime by hydrochloric acid from the mortar—the owner was compelled to take down a portion of the top. A few years ago about 30ft. more were removed by a Mr. Frith, builder of Coventry, by means of a kite, without stopping the works. The total height is now about 250ft.

We now come to the chimney at Messrs E. Brooke and Sons' Fire-clay Works, near Huddersfield, alluded to in the early part of this paper. The shaft is built entirely of fire-clay, and is 330ft. high from foundation to top, and 315ft. high from ground to top. It has a concrete foundation, and ragstone footings 36ft. square at base and 31ft. square at ground. The shaft is brick and has an outside diameter of 27ft, at the ground and an inside diameter of 15ft. At the top the outside diameter is 12ft., and the inside 9ft. It contains the following weights of materials; 144 cubic yards of concrete, 2,542 cubic feet of ragstone footings, 3.341 cubic feet of ashlar, and 2.227 cubic yards of brickwork. The cap was very large and overhanging, and has cost the firm at least £700. In the first instance part of the covering blew down. It was entirely removed and covered flat with lead. This also blew off and all had to be removed. Then the action of the acids emitted from the chimney decayed part of the stone, and subsequently one of the overlapping stones fell off. Messrs. Brooke & Son then removed all the top down to a certain distance, and rebuilt the top to its original height. The firm from their experience have arrived at the conviction that chimneys should be built one regular batter from bottom to top and no stone should be used at the top. Any overlapping to be gradually formed by hand-burnt radiated fire bricks 14 by 5 by 3.

The last chimney referred to here is at Messrs. I. C. Johnson and Co's Cement Works, Gateshead-on Tyne. It was designed and erected entirely under the personal supervision of Mr. I. C. Johnson, the senior partner of the firm. This gentleman served an apprenticeship to a builder, and was afterwards assistant in an architect's office. He has also built several cement manufacturies for himself and others, and may be considered a practical authority on construction. The concrete foundation is 30ft. square by 4ft. deep, put on solid block chalk. There are 3ft. of footings coming up until 25ft. square is met. The case goes up 25ft. square outside to the height of 10ft., but circular inside, being 17ft. 6in. internal diameter at the base. There are four walls or widths about 10 ft. high to prevent counter draught, and in one opening there is a small furnace which is wanted only at starting fire. On the four outside walls at the base the thickness is 5 bricks, and in each there is an opening to connect with the flues. Although two openings only are required, Mr. Johnson advisedly made four, so that the weakness caused by these perforations is equal on all sides. The two openings not required are built up of 9ft. work. From a height of 10ft. above footings it is all circular work to the top of the shaft. Commencing from the top of 10ft. base the thickness of the first height of 41ft. is 4½ bricks, and so on, setting off half brick (4½in.) at every 41ft., until the topmost length is 1½ bricks thick. A strong course, 20ft. down from the top, is made simply of three salient courses of brick, and the cap is about four courses salient to about 9in., then comes a blocking of 5ft. This is very simple, but has been admired for its neatness of finish. The shaft stands on ground about 50ft. above high watermark. It was built from within as follows;—Battens on edge were built in every 5ft. or 6ft., and covered with boards. When the top was reached, these were cut out and dropped down, and as they were available for other purposes the cost was comparatively trifling. The materials and men were hoisted by a crab and good Manilla rope up the middle of the scaffold, and not a single accident, even of the most trivial kind, happened during the whole building. The lightning conductor was put up by Messrs. Newall and Co.

THE INTERIOR AFRICAN SEA.

To the south of Tunis and Algeria, extending from Biskra to the Gulf of Gabes, a distance of about 240 miles, are several great depressions in the natural surface. The three principal basins are called Melrir, Rharsa and Djerid. These *Chotts*, as they are called by the Arabs, are in cross-section similar to a plate, having almost horizontal bottoms, with sides rising rapidly; they are covered to a depth, of 3 or more feet in the Djerid, with crystalized salt, containing by analysis, 95,782 to the 100 of pure chloride of sodium. The western borders of Melrir present marks of deep erosions produced by the action of water, and these depressions have generally been considered by travellers as the beds of dried-up seas.

M. Roudaire has been employed since 1864 in geodetic work in Algeria, and early became interested in the altitude of these *Chotts*. In 1872 he was engaged in triangulation on the meridian of Biskra, and so arranged his system of triangles that the last station fell very near to the west bank of Melrir.

In 1873 he ran a line of levels which proved to him that the bed of Melrir was about 100 ft. below the sea level; it was then that he first outlined his scheme for an interior African Sea in the *Revue des Deux-Mondes*. In 1874 he was commissioned by the Minister of War to make an elaborate and more careful survey of Melrir, and in six months ran 403 miles of levels. From 1876 to 1883 he continued these surveys under the Minister of Public Instruction, and finally connected the original levels in the *Chott* Melrir with the Gulf of Gabes by a system of levels in the basins of Rharsa and Djerid, in all 1,066 miles of line were run, and soundings taken along the entire length of the projected canal.

The levels were taken with what he calls "speaking sights;" the instruments used were of the Brünner and the Gravat-Lenoir types, each provided with three equidistant cross-wires. In each sight, two readings were taken on the central wire, and one on each of the eccentric wires; the sum of the upper and lower readings should equal the sum of the two middle readings, and this verification was made before leaving any station. The upper and lower readings served at the same time as Stadia measurements for calculating the distance between stations. When the sights were unequal in length, proper corrections were made for the spherical shape of the earth and for refraction; the last made from tables calculated from cöefficient of refraction in the region of the *Chotts*, as obtained in previous geodetic observations. All levels were reduced to mean tide; a tide guage having been placed at Melah in the Gulf of Gabes in 1878 and continuous observations carefully recorded. The range of tide in the gulf named is 6.56 ft.

The surface area of the *Chotts* capable of being flooded to the level of the Mediterranean, is as follows; Melrir 2,642 sq. miles, and Rharsa 494 sq. miles; the *Chott* Djerid is above the sea level. The total submersible area is then 3,136 sq, miles, and the average depth of water would be 80 ft. at mean tide.

Upon the first and all important question of evaporation, M. Roudaire states, that scientists and meteorologists have given very different and conflicting results as the outcome of their individual observations. MM. Becquerel and de Gasparin, from their experiments at Versailles, conclude that the evaporation decreases in quantity as the surface increases. At the Salt-works at Sables—d'Olonne, in vats 13×17 ft., a layer of concentrated salt-water, 1.18 inches deep, is reduced in 12 or 15 hours of a summer day, to 0.59 inches; a loss by evaporation of 0.58 inches (15 millimetres) in the time mentioned.

But in extensive salt marshes where the water averaged 9.8 inches in depth, the depth was only lowered in 10 days, 1.96 inches, or at the rate of 0.19 inches in 24 hours.

M. Roudaire concludes as follows:—

1st. All things being otherwise equal, evaporation decreases, as the surface or the depth increases; and unless the surface and depth of water experimented upon was the same, the results of observation would be different.

2nd. Experiments being generally made with an *Evaporametre* and upon sheets of water very limited in area and depth, the results are undoubtedly greater than would be produced, under similar conditions, from the surface of a great sea.

Fortunately, M. Roudaire had other data in estimating the evaporation from the surface of his interior sea. The Amers Lakes on the line of the Suez Canal have an area of 95 sq. miles and a depth of water of from 23 to 26 ft., they were completely dry before the cutting of the Isthmus. M. Lavalley, the engineer in charge, established a weir at the Mediterranean end of these lakes, and having first carefully cross-sectioned the basins and set up graduated guages, he could easily deduce the loss from evaporation. The filling was done from April to September, that is during the hottest part of the year; and the average evaporation found was 3½ millimetres (0.137 inches) in 24 hours.

As these Lakes are in the same latitude as the *Chotts* and the mean temperature of the year is 69.8° F. (21° C.), as at Biskra, M. Roudaire assumes that it would be safe to accept this as a measure of the evaporation in the interior sea.

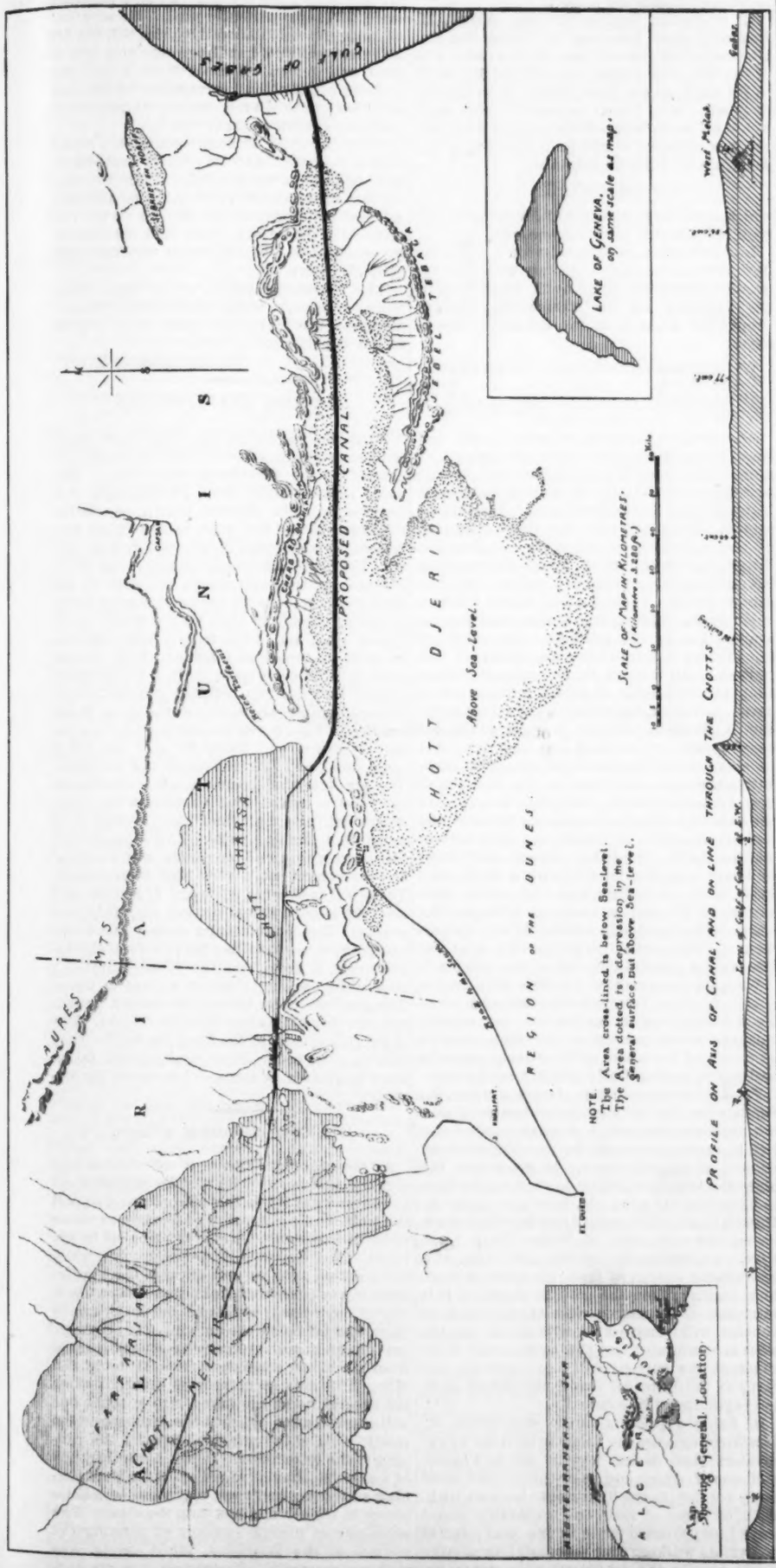
Looking from a physical standpoint at the effect of this interior sea, the author says:—The *Chotts* Melrir and Rharsa are now receptacles for the subterranean waters of an immense basin; the shore lines extending from east to west 248 miles to the *djebel* Amour, and north and south 620 miles. In certain parts there are mud marshes impregnated with salt to great depth, like Farfaria for example, a notoriously malariál spot. These marshes can not be drained for they are below sea level, but they can be covered with water by reopening the channel closed by some convulsion of nature.

The bottom of the *Chott* Djerid lies above the sea level and can be drained by connecting it with the Mediterranean or the *Chott* Rharsa; or by the proposed canal itself; 200,000 acres of fertile soil can thus be reclaimed.

Certain parties feared that the creation of an inland sea would modify the climate of southern France, and even foretold a return of the glacial period. In answer to this, Roudaire remarks that a south wind from the region of the *Chotts* and touching the coast of Provence, must now pass over about 400 miles of the Mediterranean, and that an additional body of water only 50 to 56 miles wide, the width of the inland sea, would modify but very little the hygrometric conditions. The climate of Provence, supposing this to be the case, would probable be a little more humid; and for this Provence should be correspondingly thankful, as, according to M. Martin, it now has a mean annual rainfall of only 25.62 inches, while the average rainfall for France is 26.81 inches.

But in fact France will not be affected at all. Algeria is cut from east to west by the great chain of the Atlas Mountains, lying between the Mediterranean and the inland sea, and

*Abstract of paper by Commander Roudaire, in the November number of the *Memoires de la Societe des Ingenieurs Civils*.. Translated for ENGINEERING NEWS



THE INTERIOR AFRICAN SEA.

with elevations of from 6,500 to 10,000 feet above the sea. Air currents passing north from the proposed sea would first meet the massive sides of these mountains, and to pass them would have to rise: in rising they would be rarified and considerably cooled, especially by contact with the perpetual snow which covers the mountain tops. As a consequence of this the watery vapors would be transformed into clouds, and fall as rain. It is not Provence, then, but Agieria, which needs it most, that would be benefited by the modification of climate and rains produced by an inland sea.

It may be objected that if the winds passing over 400 miles of the Mediterranean only produce light rains on the coasts of Provence, those passing over the 50 to 60 miles of inland sea would still less affect Algeria. The answer is that the conditions are unlike. France has no mountain chain running east and west, and the mean height of the Alps is less by 1000 feet than that of the Atlas and Aures. The south winds are not subjected to a cooling process conducive to the great precipitation of vapor. And secondly the quantity of moisture contained in any air current is not proportional to its length of course. It is evident that the air is saturated to the full extent of its carrying capacity in, say the first 60 miles of its course, and it traverses the remainder of its way without being further charged.

According to observations made at Biskra, the south winds prevail in the summer; from April 1 to Oct. 30, they blow 130 day out of 180. Multiplying the exposed surface by the 0.137 inches, the evaporation of the Amers Lakes, the quantity of water transformed into vapor each day, and driven towards the mountains, would be about 988,400,000 cubic feet. This would first benefit, by its consequent rainfall, the vast plains now lying to the south of the Aures, where the vegetable mold is from 40 to 50 feet thick, only needing water to make it fertile. The moisture in the atmosphere, before it was condensed into clouds and rain, would exercise a very considerable influence on the climate, by its resistance to the passage of heat. In the Sahara, where there is very little watery vapor, nights fresh and even cold succeeds days of scorching heat. On Dec. 20, 1874, at Melrir, the thermometer fell from 68° F. during the day to 19.6° during the night.

The experience at Suez supports the theories advanced. M. de Lesseps remarked before the Academy of Science, in 1874, that for twenty years past rain was rare upon the Isthmus, now tiles must be imported from France and there is considerable rain. M. Lavalley said, in 1874 and 1878, he was surprised at the vegetation rapidly developing on both sides of the canal, where before there was absolutely none. Geographers have generally regarded the *Chotts* as the dry bed of the ancient Bay of Triton; and the Arab legends accord in this with the text of Herodotus, Scylax and Pomponius Melas. Local tradition has it that Nefta and the village of Teumbib were at one time seaports; be this as it may, the fact is incontestible, that the north shore of the *Chotts*, where the Romans founded a great number of establishments, as attested by their ruins, was at that time incomparably more fertile than in our day.

From a political standpoint, the creation of this sea would give to France, as absolute master, a vast marine basin, and form to the south of Algeria and Tunis a powerful military frontier, easily defended against the robber hordes of the great desert.

As to the means and cost of execution, Commander Ronaire speaks as follows:— The length of the feeder Canal would be 111.6 miles. Deep soundings taken between 1878 and 1883, show everywhere sand and sandy marl, light, homogeneous, and easily moved, except at the entrance at the Gulf of Gabes, where a cretaceous rock formation was found. This latter is a happy circumstance, for an entrance weir can

thus be established in a material unaffected by the wear of the inrushing waters, and save much very costly masonry.

The final dimensions of the proposed Canal must be equal to the task of supplying the loss by evaporation from the interior sea when that is once filled. According to observations made at Biskra the actual annual rainfall is 10.62 inches. As a certain percentage of the evaporated water will return to the sea by the increase in the flow of its effluents by the modifications in the climate, this is estimated at an amount equal at least to the present rainfall. The total natural annual supply is thus put down at 21.24 inches: from the previously given figures of 0.137 inches of evaporation in 24 hours, we have 50.39 inches as the annual loss from this cause; this leaves 29.14 inches to be supplied by the canal per annum. Multiplying this depth by the surface of the sea we have 8.000 millions cubic yards as the total quantity required; and dividing this total by the seconds in a year, we have 249 cubic yards as the amount the feeder must furnish per second to maintain a constant water level. These figures are rather exaggerated than otherwise, for under the changed conditions, in time, the inflowing waters from the basins of the *Chotts* will be in excess of the quantity used in the estimate. With the data given above and following the formulæ of Prony and Bazin the following dimensions were assumed for the canal:

Width at bottom	65.6ft.
Depth of water	38.08ft.
Side slopes	3 to 2
Gradient	0.432in. in 3.280ft.

The gradient given should make the water level of the proposed sea 6.49ft. lower than the surface of the Mediterranean.

In discussing the question of filling the interior sea, the members of the Society generally thought that the finished section of the canal as given above would be greater than that required for the filling process. M. Roudaire thinks this logical, as the formulæ of Bazin, giving the velocity of a current flowing freely in a canal would not apply to the filling itself. The water in the canal would have its velocity increased by the pressure of the Mediterranean acting as a higher reservoir with a constant head; the more appropriate formulæ would be that applied to weir measurements.

According to the reports of the sub-committee read on June 30, M. de Freycinet presiding, the dimensions of the canal above given, seems to have been adopted by that committee, as well as the practical possibility of execution. The one point of difference was based upon the price per cubic yard of execution. M. Roudaire fixed the total cost at $32,000,000, the sub-committee put this figure at $90,000,000. The committee also doubted the saving that would result from utilizing the force of the entering current during the filling period in widening the canal, a point M. Roudaire had taken into consideration in his estimate. But contrary to the above expression, according to M. Roudaire, the committee later thought that the canal should be larger during the filling process than afterwards, when the basins were filled. To refute this, the author supposes a case as follows:

Suppose that the Seine regularly poured into the English Channel 100 c. *metres* per second; and suppose again that the Channel suddenly became dry; then according to the last theory advanced by the committee, the Seine could only carry 80 c. *metres*, for example, instead of the 100. As the remaining 20 c. *metres* must go somewhere, the drying up of the Channel would have the very unexpected result of flooding the basin of the Seine! As the committee in their last report tripled the section given by M. Roudaire and more than tripled the excavation, the original figures being 553,000,000 cubic yards, several members of the commission became frightened at the enormous figures involved, and from that moment condemned the project.

In protesting against the last theory, M. Roudaire gives his plan for filling the sea. He would first place a dam at the inner end of the 111 miles of canal and allow the canal to fill itself to sea level, which it would undoubtedly do. Then an orifice 3½ft. high would be made in the *bottom* of this dam, and the flow obtained would be measured by the well known hydraulic formulæ

$$Q = 0.62\, A \sqrt{2gH}$$

which, as he had calculated it, would give the required 249 cubic yards per second.

He further remarked that he could triple the flow without reaching any way near the figures for excavation given by M. Chambrelent, the Engineer for the commission. And in proof gives a canal of the following dimensions:

Width at bottom	98.4ft.
Depth of water	46ft.
Slope of banks	3 to 2
Gradient	2.37in. in 3280ft.

According to Bazin the capacity of this last canal would be 939 cubic yards per second, or almost four times the first given; and the excavation would be only 803 million cubic yards instead of the 1660 millions cubic yards represented. Ten years was the time estimated by the committee in which to complete the filling; the above canal would discharge 29,000 millions cubic yards per annum, and the capacity of the *Chotts* is about 229,000 millions cubic yards. Taking the total annual loss by evaporation at 6.666 millions cubic yards, or for 10 years 66.666 millions cubic yards; it will be seen to fill the sea in 10 years, the canal should carry a total of 295.666 millions cubic yards, just about ten times its annual capacity. But M. Roudaire did not propose to dig his canal entirely by hand of man, but intended to make use of the inrushing waters in excavating the canal, and that to the dimensions last given if required. His plan was to give the canal its definite dimensions through the rocky formation at Gabes (say 98ft. bottom width and 46ft. deep); but beyond that point he would be at first content with a ditch only 42.6ft. wide at bottom and 9.8ft. deep, with slopes of 45° and a gradient towards the *Chotts* of 2.36 inches in 3.280ft. With this gradient the ditch would discharge into the *Chott* Rharsa at a point 45.46ft. below the sea level.

With the sea admitted into this ditch he expected to secure for the feeder currant a velocity of 23.62 inches (60 *centimetres*) per second, this rate would increase as the ditch grew in section, and the action of the currant could be assisted by mechanically stirring up the soil.

From observations made of certain rivers, the Dimbowitza for instance, he estimates that a not excessive percentage of earthy matter carried in suspension would be one-fiftieth of the volume of passing water. In answering the objection that this earthy matter would have to be carried 111 miles: M. Roudaire quotes M. Dupaid in his "Theoretical and Practical Studies on the movement of Water," who there says, "supposing the section and slope of a great water course, in material easily moved, to be regular; then the moving liquid, if it is saturated at its source with sand, gravel, or pebbles, will transport all with it. As all the sides are saturated and the section and slope constant, the current will loose nothing, but carry to the outlet all that it has picked up in the beginning of its course."

In fixing a price upon the excavation, M. Roudaire supposes the labor to be done by excavators, such as are now in use in France, each one of which can easily move 3,300 cubic yards per day, in the light soil to be dealt with. With 65 days of rest, one excavator could move 1,000,000 cubic yards in one year; and 80 excavators working four years and four months would handle the 346,000,000 cubic yards, his plan requires.

As to the cost per cubic *metre* (1.3 cu. yards) M. Roudaire fixes this at 50 *centimes* per cubic *metre* (7.18 cents per cubic yard). He says that upon careful calculation this price will pay for all excavation and handling, wear and tear of tools, and general expenses of all kinds; and gives as proof of the correctness of his estimate the profer of responsible contractors to execute the work at that price.

The paper of M. Roudaire contains a report from a Commission of six experts sent out by MM. de Lesseps and Roudaire in 1883, to examine into the si uation from a maritime and agricultural point of view, and also as to the correctness of the surveys made and the feasibility of execution. The report is very favorable upon all points.

[The concluding points of the paper refer more particularly to the political and military aspects of the project and have little interest to the world outside of France.]

ED. ENGINEERING NEWS.

MAKING LEAD PENCILS.

With the improved machinery now used, ten hands will make about four thousand lead pencils of the cheaper grade, a day. The cedar comes chiefly from Florida, and it is received in slabs of pencil length, one for the lead to go in and the other to cover it, as may be seen by examining the end of any lead pencil. Four little grooves are sawed in the thicker slabs, for the leads, which are kept in hot glue and taken one by one and inserted in the grooves. Then the thin slab is glued to the leaded slab, and, thus united, they are run through a molding machine, four pencils coming from each slab. After the ends are rasped they are run between grooved wheels at considerable pressure for the only finish they get. This burnishes them, and they are tied in dozens and boxed for sale, mostly in plain wood, and of three degrees of hardness. The graphite used comes in a fine black powder, and is mixed with German white clay, about half and half, and then ground with moisture, forming a paste. This is pressed in dies into lengths of four leads, which are cut and then baked at a very high temperature. These sell at 85 cents, $1.50 and $2 a gross, and are very good articles, writing smoothly and evenly. The manufacturer makes about one hundred per cent., selling the pencils at eighty-five cents a gross, and the retailer makes a good thing selling them at a cent a piece. The graphite costs twenty-five cents a pound, and the clay little more than the freight. The more clay is used in the leads the harder they will be. The cedar is cut mostly from fallen trees in Florida swamps.—*Geyer's (N Y.) Stationer.*

[The Cost of Running a Train.

As the passenger sits at a car window and sees the mile posts whirl past he seldom stops to reflect what it has cost the company to pull the train a mile. A party of gentlemen, some of them experienced business men, at in the lobby of the Kennard House yesterday, when the question as to the cost of running an ordinarily heavy passenger train was raised. Several of them made estimates, but every one of them was far below the amount. The average cost of running an ordinary passenger train of from six to ten coaches is from $1 to $1.25 a mile. This may seem large at first, but when the several items are taken into account one will suspect, after all, that the estimate is too small. One of the principal items is the running of the locomotive. It has been the study of master mechanics to reduce the cost of running an engine, and each claims to be a little closer in his calculations than the other. The average cost during January of running the engines on the Bee Line, for example, was 15.77 cents per mile. Freight engines run at a cost per mile of 17.73 cents. Passenger engines

cost less, viz., 17.21 cents per mile; while switch engines, which are credited with so much mileage per day, regardless of the distances run, are run at so low a cost as to reduce the average to 15.77 cents per mile. The engines ran 34.63 miles to a ton of coal, and 16.38 miles to a pint of oil. Added to the expense of motive power is the outlay for wear and tear of cars—it is estimated that it costs 3 cents a mile to keep a sleeping car running, and the wages of train hands, etc. The expense from the item of wear and tear is increased by an increase of the speed of a train. The special trains on the Lake Shore running at a speed of about forty miles an hour, and of the fast mail of about thirty-seven miles are the most expensive trains on that line. It is not generally known what the Government pays the Lake Shore people for running the fast mail from New York to Chicago, but it ought to receive at least $800 to fully compensate it. Another little item of railway operation is the expense of stopping and starting a train, which an experienced railroad man said yesterday could not be effected at a less expense than from 18 to 25 cents at each stop.—*Cleveland Herald.*

COMPOSITE PAVEMENTS.

An experimental length of composite pavement of a novel character is now being laid in Cannon street opposite the Mansion House Station of the Metropolitan District Railway. It was devised several years ago by Mr. H. F. Williams, a well-known engineer and contractor of San Francisco and in several of the principal streets of that city the pavemant has been subjected during the past seven years to the test of traffic at least as heavy as that of Cannon Street. The fact that after this prolonged and severe trial, it remains to-day, except for a slight wear of the surface, in as good condition as when it was laid down, is sufficient proof that the system possesses such excellent qualities of resistance to wear, as to render a fair trial of it advisable for the metropolis. The mode of construction of this pavement is very quickly described. A thoroughly good concrete foundation is necessary, faced with cement which must be set hard and quite dry before the superstructure is laid on. This consists of wooden blocks about 8 inches long by 4 inches deep by 1½ inches wide, which are set upon the foundation like bricks on edge, and with the end of the grain—that is with the 1½ inch side—uppermost. Previously to being thus set, each block is dipped to half its lentgh in a boiling mixture of Val de Travers, asphalte and Trinidad bitumen. Thus coated, the blocks are laid side by side so as to break joint, and as close together as the coating of asphalte will allow, the covering insuring a space being left between the blocks of about ¼ inch all round, while at the same time it cements them firm to the foundation. The spaces are afterwards filled up with boiling asphalte so thoroughly as to hermetically seal up each block, and cement it to the adjacent ones; in this way a perfectly homogenous covering is laid over, and cemented to the foundation. Upon this covering is then spread a coating of asphalte about half an inch in thickness mixed with coarse sand or grit; the coating must essentially be of a different character to the materials used for inclosing the blocks, since it has to resist the wear of the traffic, and not to take the simply passive part of the latter. At the same time the surface covering is not so hard as that of the ordinary asphalte paving, but while thoroughly able to resist any deformation from passing loads, or alteration in structure from heat, the mixture employed has sufficient elasticity and grip to make it free of the greatest drawback and most serious evil of asphalte pavement—its slipperiness when humid. This important advantage is secured partly by the blending of different kinds of asphalte, but chiefly from the existence of the elastic cushion of cemented wood interposed between the covering and foundation. Properly laid the pavement is, as long experience as shown, an admirable one, but evidently its success or failure depends probably more than that of any other system, upon the care with which it is laid down. The absolutely essential conditions for success are: besides the proper selections of materials, a hard, regular, and dry foundation; a thorough cementation of the wood blocks to this foundation; the thoroughly complete incasing of the blocks with the asphalte glue, and the efficiency of the latter in making the structure homogeneous throughout; of very small gravel or coarse sand properly mixed with the harder asphalte, which forms the wearing surface. It is evident that to secure all these conditions essential to success, considerable skill is necessary to lay the pavement, and especially must everything be kept quite dry, and the asphalte applied as hot and liquid as possible. Without these precautions being taken, the pavement, which is of comparatively slight proportions, must invariably fail under the stress of incessent and heavy traffic. We point out these facts because the Williams pavement in San Francisco has proved itself to be all that its inventor claimed for it, and because in our opinion the Cannon street sample has not been laid under the conditions necessary to secure the success that may fairly be anticipated. Should experience show that we are right in this conclusion, the failure ought to be ascribed not to defect in the principle, which has been fully established, but to the imperfect manner in which the work has been carried out in the absence of the inventor.—*Engineering.*

RUSSIAN PACIFIC RAILWAY.

The Gigantic Project to be Undertaken Under the Auspices of the Czar.

At the present time a gigantic railroad project is contemplated in Russia, and the Czar takes the liveliest interest in the matter. In view of the immense benefit accruing to agriculture and commerce through the completion of the network of railroads in the United States, the Russian Government and capitalists have been encouraged to undertake a similar work for their large country. The project is nothing less than a "Russian Pacific railroad." The originator of the plan is General Annenkoff. He proposes that the road should start from the eastern slope of the Ural mountains, at the city of Iekaterinenburg, running through Siberia and touching the cities of Tobolsk, Yeniseisk, and Yakutsk. The road will terminate at the city of Nikolajen, and will be connected by a branch road from Yeniseisk to Yakutsk and Kiachto with China and the region of the Amoor river. A second trunk-line, starting at Astrachan, will connect with Herat, Persia, and India. A branch of this line will be built to Bokhara and by way of Kashgar to Central Asia. These immense roads in length will aggregate 11,700 English miles, and the cost is estimated at 1,000,000,000 rubles. It is judged that this stupendous work will take twenty years, so that every year 50,000,000 rubles will be expended on it. It is proposed that during times of peace the soldiers of the Empire shall be employed in the construction of the road. The Czar has decided to appoint a commission for the purpose of investigating the project.

It is believed that the project has principally a strategic significance; for after the Russians have acquired Turkestan, with its capital, Merv, in Central Asia, the road would facilitate the massing of large bodies of troops for India and Asiatic Turkey. The Russian Pacific railroad, in connection with the already existing roads, will complete a great commercial chain with Europe, Central Asia, and India. From the fort Michailewski—one of the best ports on the Caspian Sea—there exists already a railroad to Kisil Arvat, running through the most arid part of the projected line. This part has been surveyed by the celebrated Russian engineer Lessar.—*New York Herald.*

A GOOD gold-colored bronze for use on japanned work can be prepared as follows: Verdigris, 8 oz.; tin oxide (putty powder), 4 oz.; borax and nitre, each 2 oz.; corresive sublimate, ½ oz.; make all into a thick paste with oil, and fuse together.

"FORTUNES Made in Business" is the title of a book soon to appear in London, in which will be related the financial history of the Gladstone, Bright, Gathorne Hardy, and other families that subsequently became eminent for reasons not financial.

SELECTED MISCELLANY.

THE name of Suakin, the sea-port of the Soudan, is said to mean "built by the devil," and hitherto Suakin "has been chiefly famous for its connection with a traffic that justifies its diabolical appellation." Suakin is the chief port on the Red Sea from which African slaves are carried across to Arabia.

PROF. CHOWLSON, St. Petersburg, reports the invention of an electric watch, which derives its motion from a very small battery. It is said to keep very good time. No details are given regarding the construction and arrangement of its several parts, but the mechanism must be very simple, if, as it is stated, the watch has only two wheels.

THE new steamship San Pablo sailed on the 12th from New York for Shanghai, by way of the Suez Canal. She will be the first American ship with cargo to pass through the canal. Some old vessels have been taken through to be sold, and some British-built ships have gone through under the American flag.

BELGIANS will celebrate next May the fiftieth anniversary of the decree for the construction of the first Belgian railway. M. Charles Rogrèr who was then Minister of Public Works, is still alive, and the large square before the Northern Terminus will become the site of a monument to his memory after his death. Belgium was the first country on the Continent to construct a railroad.

THE population of Belgium now about 5,500,000 souls consumes annually alcoholic liquors to the value of 480,000,000f., which is 66 per cent. more than 30 years ago. Compared with 40 years ago, the number of the insane has increased by 104 per cent., of suicides by 80 per cent., and of condemned criminals by 135 per cent. In 1850 the number of places where alcoholic liquors were retailed was 53,000; it is now 130,000.

AT the annual Town Meeting in Enfield, N. H. held 3 weeks ago, for the first time in the history of the town it was voted not to raise any money for town expenses, the income from railroad and savings bank taxes being ample to meet the expenses for the coming year. The tax to be assessed in April cannot be much, if any, over $8.50 on $1,000.

ON NOV. 4, 13, and 21, Mr. Raynard observed with an 18-inch silver-on-glass reflector a new belt on the planet Saturn, and has read a note on the phenomenon before the Royal Astronomical Society, London. A narrow dark belt was noticed stretching across the disk of the planet, and at moments of good definition it was seen fading away toward either limb. The color of the belt was a dark blue-gray, very different from the reddish brown of the Jupiter belts.

MOUNT Everest, 29,002 feet above the level of the sea, seems not to be after all the highest peak of the Himalayan chain. Mr. Graham and his two Swiss guides, while attempting to scale some of the high summits of the range distinctly saw two peaks to the northwest of Mount Everest, which they believed to be much higher. On hearing of this discovery Gen. Thuillier, of the Indian Trigonometrical Survey, thought it quite probable that there were higher mountains in the chain than Mount Everest.

THE Lynn and Boston Horse Railroad Company started in 1860 with 8 employees, 2 cars, 19 horses. The original line was from West Lynn stable to Green street. The capital stock was $200,000, and the earnings of the first five years were $150,000. In 1875 there were 102 employees, 38 cars, 241 horses, and the earnings were $166,000. In 1883 there were 213 employees, 114 cars, 514 horses, and the earnings were $302,000. The company operates 28½ miles of road and leases and runs over 6 miles additional. Lynn has a horse car service equaled by few suburban cities in New England. The longest single line is from Cornhill, Boston, to Peabody Square, a distance of 15 miles.

TWO chains of the following extraordinary dimensions, for use on the large floating bridge connecting Portsmouth and Gosport (England) have been recently made by Messrs. Jones & Lloyd, at their Cradley Works. Each chain was the length of 640 yards, consisting of nearly 5,000 links, the diameter of iron being 1 11-16th inch, and the weight of each chain 21 tons, tested to a tensile strain of 40 tons, or 20 per cent. over Admiralty test, the actual breaking strain being proved to be 70½ tons.

THE results of the suryey of Palestine, &c., have begun to create quite a stir among Biblical and other students. The statement that at the time of the Exodus the Red Sea and the Mediterranean were continuous is startling. If this turns out to be correct, a warning will be given to writers on the distribution of the human race, plants, &c., when so severe a blow is delivered to the prevailing assumption of the practical immutability of the great land and water masses since the appearance of man upon the earth. Great changes must have occurred according to Prof. Hull, within historic times.

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WE have received from the Institution of Civil Engineers, London, "Notes on Cylinder Bridge-piers," by John Newman; "The Generation of Steam and the Thermodynamic Problems Involved," by William Anderson; "On Electrical Conductors," by William Henry Preece, with discussion; "The New Eddystone Lighthouse," by Wm. Tregarthen Douglass.

LOCAL GOSSIP.

Fifth Avenue New York City is to have $350,000 worth of new paving this year. It costs $11,500 a year to clean the New York Post Office building: Charles Lyman, superintendent of the Mills Building, Broad street, testifies that it costs about $10,000 a year to clean that building. There are under the janitor sixteen porters and twenty-one women cleaners. The building contains 220,000 square feet of cleaning space, and the annual cost of cleaning is less than five cents a foot. There are six elevators in the building, and to run them and heat the building 1,300 tons of coal are used annually. The coal is bought by contract, and costs $5.15 per ton of 2,240 pounds. G. Livingston Morse, joint owner of the Morse building, testifies that it costs $2,320 a year to clean that building—about five cents a square foot of cleaning space. It takes between 250 and 300 tons of coal a year to run the two elevators and heat the building nine stories high.

A SAFE ELEVATOR.

A number of gentlemen met on Saturday afternoon, the 15th in the factory of Messrs. Miller & Sons, West Twenty-sixth street, New York, to witness the testing of a safety appliance for elevators, patented by Mr. John Hodges, of Westfield, N. J. Thirty three times the inventor let the car fall at points between the basement and fifth floor, and every time the car was caught on the projecting pawls after falling only a few inches. When several tests had been made many of the gentlemen present got into the car and experienced the slight shock, and some of them remained in the car with the inventor when he tested it from the fifth floor. All expressed their admiration for its manifest safety for the gratification afforded them by witnessing an exhibition test that is unprecedented in the history of elevators. Mr. Hodges was desirous of testing it fifty times, but the spectators were satisfied that he had fully demonstrated the safety of his appliance and that further proof was unnecessary. A car is on exhibition at the Cooper Institute Hall, No. 1, which has fallen nearly one hundred times, always stopping on the movable pawls with which the sides are provided. The car can be stopped from the inside so that the man running it can let it rest on the pawls whenever he chooses: this, the inventor claims, is a great desideratum for freight elevators, inasmuch as the car can have a bearing while being loaded at a floor.

New Railroads in Nicaragua.

The Ferro Carril de Nicaragua, like the other new roads in that state is being built by Americans. H. D. B. Norris, the contractor, was formerly superintendent of the New Orleans, Jackson & Great Northern R. R., Wm. Cook, Chief of Construction, and Addison Marbury, Chief Engineer, are Virginians. The road as completed runs from Corinto, on the Bay of Realjo, on the Pacific, to Momotombo on Lake Managua, a distance of 60 miles. Leon, the largest town on the route has 40,000 inhabitants.

Another road is being built from Managua to Grenada, 36 miles; the rails are now being laid. Still another road is projected from Managua to Pueblo Neuvo, 40 miles. The gauge of the railroads is 3 ft. 6 in.; 5 cents a mile is charged for first class fare. The locomotives and cars are all of American manufacture; and the lines thus far built have all the business they can transact.

BY RAIL TO BUENOS AYRES.

While France, through de Lesseps and his navvies, is cutting away the narrow isthmus that now ties North America to its Southern neighbor, America, in its Senate, has under consideration a bill, the ultimate object of which is the uniting of the two great Continents by an iron highway.

We live in a practical and unsentimental age and the great engineering feats of the last decade or two promise greater things still for the near future. Already there is an all rail communication between the Canadas and the City of Mexico, and to extend this system to the extremes of South America simply requires capital to call fortn the engineering skill and experience and energy we already possess. Calling the distance to be built 6,000 miles, and putting the cost at $40,000 a mile, $240,000,000 is the sum total, only twice the estimated cost of the Panama Canal. And with the vast commercial interests that such a mid-continental line would develop, the scheme possesses financial possibilities far beyond the tolls collectable from a canal between the two oceans.

The annual foreign commerce of the Spanish American States is now over $600,000,000 and as yet the country yields comparatively little of its possible treasure; of this commerce Europe, through its ships, controls three-fourths. Aside from the benefit that might accrue to the United States from the construction of the line proposed by the Cockrell bill, now pending before the Senate, is the undoubted fact that this line would be the parent of innumerable feeders, stretching into the remote corners of the heart of South America, corners teeming with wealth that is now inaccessible.

The bond would be not only commercial, but political; far-reaching in its effects; it would do more than armies in quelling sectional strife, and by contact with a higher civilization teach the average Spanish-American that there are better methods of building up a prosperous state than by a semi-annual revolution.

We have spanned the ocean by cables, have cut, and are cutting continents; we propose inland seas, and why not a railroad whose only remarkable feature is its length. Should the U. S. Senate appoint the commission asked for in the Cockrell bill, the first step in this great scheme is taken; for this commission is to visit the Central and South American States with the special object of investigating railway inter-communication, which, in fact, is the vital point in the bill.

The fact that railroads can compete but badly with water carriage for long distances, should be considered, in estimating the immediate profit to North America; but the products of the country must first reach the seaboard before ships can load, and the hope still lingers in the American breast that by the time such a railroad could be built, we would again have American ships to carry such freight as is too bulky for an all rail route.

With the practical results well established, the raising of the capital required would be the smaller portion of the task; the countries affected and benefitted could well afford to guarantee the interest on the pro rata sum. The enterprise is possible of achievement, and is worthy of the closing of a century that has already witnessed such wonderful and radical marks of progress.

The Engineers' Society of Western Penna.

The Society met on March 19th, at their rooms. The committee appointed to prepare for the reception of the board of U. S. Engineers, who are to visit Pittsburg about April 1st. reported that they had secured a special train from the Penna. R. R., by which the mills at Johnstown and other places could be inspected.

Col. T. B. Roberts then read a paper upon "The Influence of Forests upon Floods." After illustrating by maps and diagrams the general European experience, he concluded by stating that the records of many years, on five of the most important rivers of Europe, indicate that there is no evidence to support the theory that floods are increasing in height or frequency; and it is still an open question whether the destruction of the forests causes a less annual water discharge.

In referring to the late flood on the Ohio, the speaker thought it caused entirely by an unusual combination of natural circumstances; the area covered by the preceeding great snow storms was immense, and a combined thaw and a protracted rainy season followed. He thought that the destruction of the forests had little to do with the unequalled height of the flood.

IRRIGATION WORKS IN ITALY.

The irrigation system of Italy is supposed to be the most perfect in existence; it is constantly being added to, as it has proved the best defence possibly against the inundations so common in the northern provinces. According to recent official statistics, the irrigation canals of Piedmont have a capacity of 141,000 gallons per second, distributed over 214,400 acres; and those of Lombardy, 107.000 gallons per second, distributed over 268,864 acres.

These immense works have been built at great expense. Thus the Cavour Canal, lately constructed and fed from the Po and the Dora Baltra, supplies 38,000 gallons per second, waters about 6,400 acres, and costs $8,000,000 or $30,67 per Lin. ft; it was built in four years.

A small auxiliary canal, with a capacity of 21,000 gallons per second, cost, $19,28 per Lin. ft.

The largest canals are those of Cavour de Muzza, d'Ogliaio and Navigliogrande. The sma lest furnishes 12,000 gallons per second. The numerous canals are used not only for the purpose of irrigation but also to furnish a motive power for raising water to higher districts. *Le Genie Civil.*

The Public Works of Buenos Ayres.

We are indebted to Mr. E. P. Adams of Boston for a supplement to the *Buenos Ayres Herald*, Jan. 24, 1884, containing a general review of the works executed in 1883 and some of those proposed. As very few of our readers have an idea of the activity being displayed by this distant republic, we give the following extracts from the official reports:

Railways.—The Central Northern R. R., on gross receipts of $848,355, shows a net profit of $425,039; the Central Argentine R. R., gross receipts $1,814,186.93, net profit, $1,116,796.67; East Argentine Railway, gross receipts $148,705.89, net profits $34,019.15; Buenos Ayres & Campana R. R. gross receipts for 9 months, $234,722.12, net profits in same time, $98,581.80. All of the above roads are adding to their rolling stock, improving their line, and report in each case an increase of business over 1882.

Surveys have been made for the extension of the Andine Railway to San Juan; plans, specifications and estimates are almost completed. The Central Northern has finished surveys and plans for the construction of the section from Tuscuman to San José de Matau, and surveys for further extension are almost completed. Orders have been issued for the construction of a branch to Chumbicha, La Rioja and Catamarca. A Railway to La Mejicana, and another to Missiones are being surveyed.

Construction on the Andine Railway is in an advanced state, and the line was expected to reach Santa Rosa, 38½ miles from Villa de la Paz, last February; they expect to reach San Juan this year. With the rolling stock now ordered from the U. S. this road will have 55 locomotives, 61 passenger coaches, 16 baggage cars, and 596 freight cars; the total length of the line from Villa Maria to San Juan will be 473 miles.

The Northern Railway has been somewhat delayed in its construction by difficult ground and the heavy nature of the work: the tunnel has been completed. The line is expected to reach San Jose de Matan this year; with stock now contracted for in the U. S., the Company will have 75 locomotives, 82 passenger coaches, 35 baggage ca s and 1,478 freight cars.

Though some orders have been sent to Europe the locomotives and cars come from the U. S., where they can be more speedily obtained. The Creusot Co. have furnished the material for the track for the Northern and the Andine Railway; Bolckow, Vaughan & Co. have a contract for steel rails for 155 miles of line; the rails are of the Vignolles type and weigh 40.2 lbs to the yard; the price is $35 (£7) per ton of 2,200 lbs. free on board at Rosario.

Hydraulic Works.—Surveys are being made for the utilization of the water of Chubut River for irrigation purposes; two dams and canals are to be built. Plans are being made for the improvement of the ports of Atalaya, Corrientes, Rosario, Santa Fe and Concepcion Del Uruguay. Work is now in progress on the port of Santa Fe and San Juan, and on the San Luis Canal.

Bridges.—Bridges have been built over the rivers Sali and Desaguadero, and another is being built by the Creusot Co. for the river Gualeguay.

Under the head of *Annual Reports*, the Central Northern Railway puts its annual expenses at 45 per cent. of the receipts; this road carried 67,643 passengers and 125,299 tons of freight; the first being an increase of 45 per cent., the last of 67 per cent. over the business of 1882.

The Andine Railway reports 19,145 passengers and 66,500 tons of freight in 1883; 72 miles of new line were opened in the year, and from 1500 to 2000 men employed in the work of new construction.

The Eastern Railway reports receipts and expenses as follows:—

TRAFFIC RECEIPTS.

Passengers (16,117)	$ 31,382 68
Goods (37,476,233 kilos.)	128,062 08
Parcels (47,850 ")	1,631 09
Luggage (23,295 ")	751 95
Telegraph messages (2,059)	1,085 71
Almacenes	294 79
Special trains	120 12
Rents	1,229 15
Sundries	4,083 70
Total	168,801 27

EXPENSES.

Ways and Works	$ 41,422 78	
Locomotives	22,955 41	
Workshops	8,805 25	
Carriages and Wagons	8,266 60	
Traffic	19,088 78	
Management	30,753 19	
		131,350 01
Net Profit		$37,451 26

Sanitary Works.—Works are under contract with the city of Buenos Ayres for the building of sewers, the construction of an outfall canal and the distribution of water; contract signed July 4, 1883; money paid out to date $180,779.36. The works for increasing the water supply were finished on Dec. 16, 1883; they include new lines of 36, 33, and 24-inch pipe laid; the Managing Engineer was D. Carlos Nystromer, the representative of Mr. Bateman. The old water works have been in use 15 years.

PERSONAL.

P. M. COOMBS was elected Engineer and Superintendent of Sewers of Bangor, Me., on March 24.

TRAFFIC SUPERINTENDENT MUIR of the Oregon Improvement Co., has a three years contract with the company, and his salary is stated to be $15,000 per annum.

AMONG the deaths from yellow fever on the Isthmus of Panama are those of a son and daughter of Chief Engineer Dingler, of the Panama Canal.

EDWARD H. PHELPS, Civil Engineer and son of the Hon. Edward I. Phelps of Burlington, Vt., died on March 20. Mr. Phelps at the time of his death was Chief Engineer of the Michigan Central R. R., and his last active work was in connection with the Niagara Cantilever bridge.

T. A. MATSDAIRA, the new City Engineer of Bradford, Pa., is a native of Japan, and the first man of his nationality to be chosen to a civil office in the United States. He is the son of a wealthy Japanese nobleman, and came to this country in 1870 to be educated, not at the expense of his Government, but at the individual expense of his father, who planned to have his son return home and be appointed to a high position under the Japanese Government. Upon being graduated he asked consent to remain a few years longer to practice civil engineering. His father replied that unless he came home on the next steamer his allowance would cease, and he need expect no more help from him. The son replied that he would stay, and the father became angry and wrote to his Japanese friends to have nothing to do with the young man. He stayed and practised his profession, acting for some time as assistant engineer of the Manhattan Elevated Railroad Company, in this city, and afterward for three years as chief engineer of the Union Pacific Railroad in Wyoming, Idaho, and Montana.

TO JAMES MCCREA General Manager of the Pan-Handle Railroad, is due the system of railroad work by which locomotives are kept constantly in service by relays of engineers and firemen. McCrea began his railroading as a rodman. At 26 he was Superintendent of the middle division of the Pennsylvania Railroad. This was ten years ago. Freight trains were then run through to their destination by the same "crew" with which they started. At night they were side-tracked, while the crew slept. At the end of the line the locomotive was idle until the crew could sleep and return to clean it up. Young McCrea proposed that the moment an engine came in wipers should be set at work to clean it up, and that a new engineer and crew should take it out as soon as ready; and that relays of engineers should be placed along the line to keep the trains continually moving. The management was slow to try the plan; but McCrea persisted in a asking a trial. In a year's time forty-three locomotives were doing the work formerly done by ninety-three, and the road was saving $250,000 per year. The plan is now general.

THE BROOKLYN BRIDGE.

On the 24th of January the New York and Brooklyn bridge had been open to the public eight months, and the opportunity was seized by the *Herald* to inquire into the receipts from those who had made use of it to compare with the cost of maintaining and paying for the structure. The results are interesting and suggestive. The bridge treasurer's books show that 4,635,000 pedestrians used the bridge in eight months, an average of say 19,312 a day. The cars (running four months only) carried 2,181,720 persons, an average of 8,978 per day. The receipts and tolls of all kinds were:

	From New York	*From Brooklyn*	*Totals.*
Pedestrians	$25,372	$ 9,978	$46,350
Car pasengers	47,286	61,800	109,086
Vehicles	24,807	25,038	49,845
Totals	$97,465	$107,816	$205,281

These figures show the growing popularity of the bridge car service, and indicate the excess use of the bridge by those entering it from the Brooklyn end. This is explained by the fact that many Brooklynites prefer the ferry route home as offering better chances for a seat in the street cars on the other side of the river, said cars starting from the ferry-houses and reaching the end of the bridge (during the late afternoon hours) well filled. The bridge treasurer estimates that, with the rentals for warehouses (under approaches) included, the annual receipts may be placed at $521,510. The running expenses have greatly exceeded earlier expectations. They were to amount to about $150,000 per annum, but instead were $148,753 in seven months. The estimates of "help" needed appear to have been too low. Eighty policemen are required instead of fifty. Three conductors to a train instead of one. five ticket sellers at each end instead of three, etc. Brooklyn, which is to pay for two-thirds of the bridge, has four issues of bonds (4, 5, 6 and 7 per cent.) aggregating $11,560,000, and New York (at corresponding rates) $5,000,000 worth of bonds; total, $16,560,000. The annual interest is: New York, $339,675, and Brooklyn, $679,350; total, $1,019,025. These bonds fall due at dates varying from 1899 to 1924. The total outlay, on this basis, is estimated:

Principal	$11,560,000
Interest	28,000,000
Interest past paid	3,000,000
Total ultimate outlay	$42,560,000

The estimated annual running expenses ($280,000) leave but about $240,000 from the present annual receipts ($521,510) with which to meet the debt, about $1,000,000 in interest alone falling due each year. But the bridge traffic will grow, of course, and lower car fares and improved and more extended service may enlarge the receipts from that source. The storage room for rent at either end, too, should bring a handsome rental.—*Bradstreet's.*

CORRESPONDENCE.

PROBLEM IN GEOMETRY.

Special Correspondence Engineering News.

104 WASHINGTON ST. PITTSBURG, March 19, 1884.

EDITOR.—In answer to the question (No. 11 of your issue) concerning the calculation of diagonals in an oblique parallelogram, I wish to state that there cannot be such a formula, as the diagonals are not only functions of the sides but also angles of the oblique parallelogram.

P. BROSOG.

PROBLEMS IN COMPOUND CURVES.

PHILADELPHIA, March 17, 1884.

EDITOR ENGINEERING NEWS.—None of your correspondents on the Problem in Compound Curves have given the correct answer. Mr. Chauvenet has overlooked the fact, as I myself did, that it is a condition that the new line shall be equal to the old line in length. The following, I think, is correct, and I wish the proposer would try it on this ground and give the result. He should go back from the first P. C. a distance of 177.4 feet, or to station 385 + 68.6, and run, a 2° 11½′ curve, or one whose radius is 2614.23 to Station 409 + 82 which would be on the old 5 degree curve, and the new curve would be tangent to it at that point.

C.

Special Correspondence Engineering News.

ROCHESTER, Mar. 18, 1884.

(*See* ENGINEERING NEWS *of February* 23.)

EDITOR ENGINEERING NEWS:—Let a = the angle of that part of the 5° curve which is to be revised. Assume values for a as close as possible, plot if necessary. If a is too small, new line will be shorter than old line. If a is too large, new line will be longer. Draw the tangents of the three curves. For any assumed value of a all parts of the curve can be determined. First, the tangent of a, $A\,B$. Then solve triangle $B\,I\,D$, the angles and longer sides being known. Tangent of new curve $= A\,B + B\,I = A\,I$. Total angle 38° 48′ + a. $E\,F$ = new tangent $-(E\,D + D\,I)$.

Compare lengths of lines.

If $a = 10°$, new line is 15′ shorter than old, between $P.C.$ and $P.C.C.$

If $a = 20°$, new line is 22′.2 longer than old line.

Then $15 : 15 + 22.2 :: x : 10$. $x = 4° 2′$. $a = 14° 2′$.

Solve as before, and lengths of lines agree.

$P.C. = 385 + 66.9$. $P.C.C. = 407 + \frac{14° 2′}{5} = 409 + 80.7$.

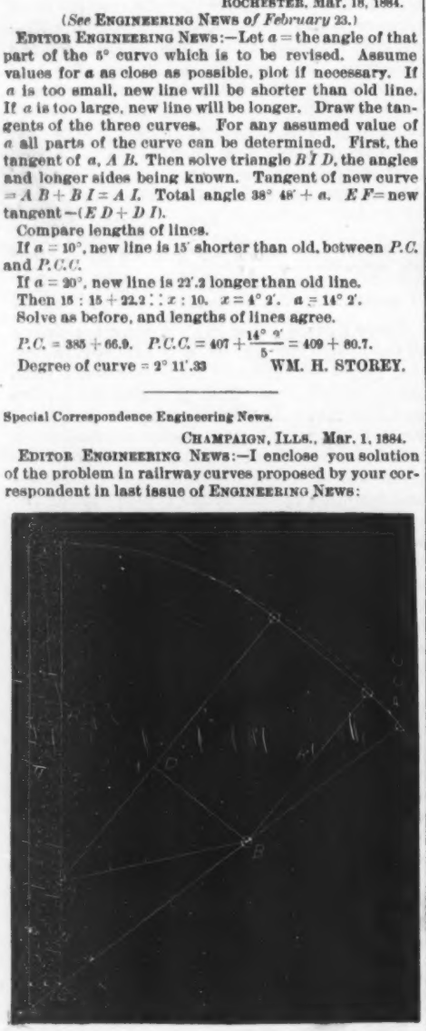
Degree of curve = 2° 11′.33

WM. H. STOREY.

Special Correspondence Engineering News.

CHAMPAIGN, ILLS., Mar. 1, 1884.

EDITOR ENGINEERING NEWS:—I enclose you solution of the problem in railway curves proposed by your correspondent in last issue of ENGINEERING NEWS:



Let x = dist. beiween P. C.'s.
Let y = required radius.
Det a = required intersection angle.
Draw $B\,D$ perpendicular $A\,D$.
$B\,D = 660.'7$. $A\,D = 761.'8$.
Solving $\triangle\, A\,B\,D$ we find $A\,B = 1009.'9$. $D\,A\,B = 40° 51′ 36″$
Then in the $\triangle\, A\,B\,C$—

$$A\,B = 1009.'9,\ A\,C = y - \frac{x}{\tan a} - R,$$

$$B\,C = y - \frac{x}{\sin a} - R,\ L\,A = 100° 20′ 24″,\ L\,C = a,\ L\,B = 79° 38′ 36″ - a,$$

By formula $\sin C : \sin B :: B\,A : A\,C$, we obtain after reduction $\tan a = \frac{x + 993.5}{y - 1728.8}$ (1)

By formula $\sin C : \sin A :: A\,B : B\,C$, we obtain similarly $(y - R)\sin a - x = 993.5$ (2)

From the condition of equal lengths we obtain:

$$x + 1954' + (a - 38° 48')\frac{\pi R}{180°} = \frac{\pi}{180°} y a. \quad (3)$$

By further reduction of these equations we obtain:

$$\tan \tfrac{1}{2} a = \frac{582.52}{x + 993.5} \quad (4)$$

$$a = \frac{x + 1177.75}{\frac{\pi}{180°} y - 20} \quad (5)$$

$$y = \frac{x + 993.5}{\sin a} + R \quad (6)$$

The solution of these equations for x, y and a presents the difficulty that a being involved as an angle and also as a trigonometrical function, in order to effect the solution, we must substitute for $\sin a$ and $\tan a$ their values in terms of a, each of which is an infinite series. It is better then to obtain the result by a series of trials as follows: First, by plotting the line accurately and employing the construction for passing a circle tangent to a straight line at a given point, and also tangent to a given circle, we can obtain an approximate value for x, which is 200′. Then employ equations (4), (5), and (6) as follows: (See table.)

x	a	a'	y
200′	52° 02′	52° 07′.7	2630′.2
178′	52° 52′.6	52° 51′.4	2515.6
184′	52° 38′.6	52° 39′.3	2627.6
182′	52° 43′.3	52° 43′.3	2623.6

The quantities (x) are assumed.
" " (a) are computed from (4).
" " (a') are computed from (5).
" " (y) are computed from (6).

The two lines are of the same length when $a = a'$.

We arrive at the last result by a few trials, as indicated in the table. From the values of x, y, and a in last line of table, we find the length of the curve to be 2414.'4. The two lines differ by less than .2ft. We thus obtain the following results:

$P.C. = 385 + 64$. $P.C.C. = 409 + 78.4$. $R = 2623'.6$.

Intersection angle = 52° 43′.3. Degree of curve = 2° 11′.

J. SONDERICKER.

DIVIDING RIDGE, Mar. 12, 1884.

EDITOR ENGINEERING NEWS:—The problem in compound curves, which is under discussion in the correspondence column of your paper, will give three equations, as below:

$$(y - r_1)\sin w = x + (r - r_1)\sin \phi + a\cos \phi.$$
$$(y - r_1)\cos w = y + (r - r_1)\cos \phi - a\sin \phi.$$
$$\frac{\pi}{180} w\, y = x + l + a + 20\,(w - \phi).$$

y = radius of new curve.
w = angle of new curve.
x = distance between new and old $P.C$'s.
l = length of first curve.
r = radius of first curve.
ϕ = angle of first curve.
a = length of intermediate tangent.
r_1 = radius of second curve.

These equations are obtained through projections on the radius through new $P.C.$, and on a line perpendicular to this through the new $P.C.C.$

The three equations point to the fact that there is a curve, and only one, to satisfy the given conditions.

G. H. V.

EARTHWORK PROBLEM.

IOWA CITY, IOWA, March 17, 1884.

EDITOR ENGINEERING NEWS.—I send you the following in answer to "Earthwork Problems" in the issue of the 8th.

(1.) The Prismodial Formula will give the true volume of the cut mentioned. The writer demonstrated this fact many years ago.

(2.) The "distance out" from the side of the roadbed at the point half way between stas. 216 and 217 is (6.76 + 301) ÷ 2 = 4.90.

A cut at the same point is (6.76 + 6.08) ÷ 2 = 6.42. Hence the slope is $\frac{490}{6.42} = .763$

(3.) The area, in view of the answers given above, is easily found; but as I do not use it in finding the volume of the cut, I do not stop to find it.

(4.) The true contents, if I make no mistake in the multiplications, etc., is equal to 570.76 Cu. metres.

P. H. PHILBRICK,
Prof. Civil Eng., S. W. I.

RACKAROCK BLASTING POWDER.

240 BROADWAY, NEW YORK, March 13, 1884.

Special Correspondence Engineering News.

I send you the following, taken from a letter to us from a "blaster," at the Mines of the Hudson River Ore & Iron Co,

"March 11th, yesterday, I had prepared 150 pounds of Rackarock powder for blasting. I had inserted 35 electric fuzes in as many cartridges, and was all ready to charge the holes, when a miner came along carrying a lot of cotton waste under his arm, and a lamp in his hand.

The waste took fire from the lamp, the miner became frightened, and threw the blazing waste into the box containing the powder.

The waste, the box, and the powder burned up completely, the fuzes exploded, but the powder did not explode, not even those cartridges that contained exploders. If we had been using any other kind of powder, every man of us would have been killed."

I thought this might interest you, as public attention is now so much called to dynamite, etc.

Yours truly
N. W. HORTON.

A NEW MOTOR.

BOSTON, Mar. 12, 1884.

Special Correspondence Engineering News.

I notice in your last issue, March 8th, of ENGINEERING NEWS, an article entitled a "new motor," in which reference is made to an invention claimed by one Cobwell, which consists in the use of Bisulphide of Carbon as a motive power in connection with a steam engine to multiply the power.

The article also says that a large amount of money has been invested in this "new motor," by various parties, which is probably true, judging from the excitement in relation to it in some sections, and particularly in the city of Lowell, Mass.

I would suggest that by calling the attention of your readers to an arrangement of that sort which was tried at the Atlantic Works in Boston ten years ago, then called the Ellis motor, and which proved a failure, you will perhaps do them a good service if you do not those who are desirous of relieving them of their surplus cash.

Very truly yours,
M. M. TIDD.

MARKET PRICE. NO. 2.

Special Correspondence Engineering News.

No. 63. COURT ST. BOSTON.

MR EDITOR.—I was glad to see the article from "$\frac{dy}{dx}$" in the NEWS of March 8th, and wish he had signed his name to it, for although I cannot agree with him in every particular, I think that this is the most vital question before our profession at the present day.

It would be well to drop some of the theoretical discussions for a time and take up the very practical question of "Bread and Butter."

As our country develops year by year, more and more is required of the Engineer; the more thickly settled and valuable a country becomes, the more public works are demanded; the more expensive they become, and the greater skill and judgment is needed to build the best works for the place for the least money.

At no time in the future will it be easier than now for the Engineers of this great country to establish a standard price for services, and if they are ever to be a power in the land, this standard must be established and kept as a minimum; every one will respect the profession more for it and will be better satisfied in every way in the long run.

My idea would be to charge for all surveying,—except that done in connection with construction work,—by the time spent on the work; travelling expenses extra.

Then for construction work charge a percentage on cost, one price for Surveys, General Drawings, Estimates and Report; and another price for the whole work, taking the Site, and finally turning over the finished works. This would of course include all the first and also detail drawings, laying out and superintending the work, and when done, a general plan and a set of detail plans should be turned over to the owners.

I do not look at the present engineering societies for much help in this matter, although it could all be done by them and perhaps better that way than any other; but I think a special combination may have to be formed to carry out this move. I wish others would give us the benefit of their ideas in regard to this matter through the "NEWS."

I should like to know how and at what rate charges are made in other countries. I may be totally wrong in my ideas; and all I can say in their defense is that they are the outcome of several years of practice in a sharp competition, and I, for one am tired and disgusted with the cut-throat policy. Let us have a standard price, make it high enough to do first class

work and then the question will be; who can do the best work with the least money, instead of, as is too often the case now, who will do the necessary engineering work for the smallest fee.

If a man wants a difficult surgical operation performed he doesn't go hunting around for the man who will do it for the least money, for he knows that a large number of the best men belong to the great medical societies who have a standard, or at least a minimum price, and when he steps outside of that price to a cheaper one he is perhaps running a great risk

Let the public once understand, that most of the Engineers have a standard price, and they will soon get to feel in the same way about us, and our work. I know it will be very hard indeed to establish a scale to fit all cases, but now let us hear from the readers of the "NEWS" who do work in competition and as many of the salaried men as may be, and see if something cannot be done.

T. WILLIAM HARRIS.

We have received a number of answers to the "compound curve" question propounded by a "Subscriber," Feb 23. Space forbids our giving them in full, so we simply show some of the various results. I. P. Genthon makes the radius required 1656.5 ft. and the degree of curvature 3°, 27′ H. C. K. makes the radius of 1697.52 ft. and the curvature 3°, 22′, 32$\frac{5}{10}$″. J. Sondericker gives, as above, radius equal 2623.6 ft., curve 2°, 11″. "C" corrects his formula given in the NEWS of March 8, by substituting as follows:

$$\left\{\text{Sin. } (28° 48' + \frac{x}{20}) + \text{Sin. } 38°.48'\right\} \text{ instead of } (1 + \text{Sin. } 38°.48')$$

We must leave our readers to select from the above and preceding results, and beg that the flood of answers cease. The problem is sufficiently "indeterminate" to bring a different result from each and every correspondent.

THE SPEED OF TRAINS.

Rule. Take $\frac{3}{11}$ of the locomotive wheel diameter in inches and the result is a number which represents in seconds the period during which the revolutions of the wheel equal in number the speed of the train in miles per hour.

Example. A locomotive wheel is 55 in. in diameter. If you observe in $\frac{3}{11} \times 55 = 10$ seconds that it makes 24 revolutions, the speed of the train is 24 miles an hour.

The proof of this rule is very simple. If d be the diameter in inches, u the number of revolutions in t seconds, we find the revolutions per hour equal $\frac{u}{t} \times 60 \times 60$ revolutions; from this can be deduced a distance v travelled in miles per hour; $v = \frac{u \times 60 \times 60}{t} \times \frac{\pi \times d}{5280.12} = \frac{0.179d}{t} u.$

If we assume $v = u$; we have $t = 0.179d$; but making $t = \frac{3}{11} d$, it results that $v = 0.985\ u$. The error will be 1½ per cent., which, however, is diminished by the unavoidable slip, so that the rule may be considered sufficiently accurate for practical purposes.

For the metrical measures this rule is as follows: Take the diameter of the wheel in decimetres and add thereto one-eighth of it: the result is the number of seconds during which the revolutions of the wheel must be counted to obtain the number which is equal to the number of kilometres travelled by the train in one hour. The error in this case will be one-half per cent.

FREDERICK STEINER, C. E.
Professor in the High Polytechnical School, Prague.

THE TEXAS CAPITOL.

Gen. R. L. Walker, who is acting as the supervising architect of the new State Capitol at Austin, Tex., which a Chicago syndicate is building for that State in exchange for a concession of 3,000,000 acres of land. In reply to question how the structure was progressing said: "All the excavating is done and the concrete is already in. We have just begun to lay stone. There are about fifty stone-cutters at work and enough men to handle what they turn out. The building will be limestone trimmed with marble and granite.

All the stone is obtained in Texas, and most of it within twelve miles of Austin. We are under contract to finish it by Jan. 1, 1888, and when completed it will be one of the finest structures in the country. It is in the style of a Greek cross, the length of the cross being 260 feet. The entire length of the front will be 593 feet and the height of the dome 300 feet. I can give no idea about the cost, as I have not seen the estimate."

THE late Prof. Jevons, in a treatise on the coal supply of Great Britain, assigned to the year 1883 an output, on the principle of estimation he adopted, of 178,100,000 tons. The actual number of tons of coal mined was 163,750,000.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(Continued from page 142)

DCIX. GALESBURGH, ILL.

Galesburgh, Knox County, Illinois, in lat. 40° 67′ 29″ N. long. 90° 21′ 17′ W. is on level ground. Settled in 1835; it was incorporated a city in 1857.

Water-works were built in 1883 for a private company by Nathan Shelton, after plans of F. E. Jasel, C. E., taking the supply from a well 15 feet in diameter and 70 feet deep, sunk to the second gravel stratum. The water rises to the surface of the ground. A reservoir for storage is constructed 100 by 175 feet, supplied from an artesian well, and kept as a reserve for sudden draught.

The water is pumped by Worthington compound duplex pump of 14 and 20 inch steam, and 12 inch water cylinders of 15 inch stroke, into a plate iron stand pipe 15 feet in diameter and 132 feet high. There is also a Worthington high pressure pump of 20 inch steam and 12 inch water cylinder, of 15 inch stroke.

Distribution is by 8 miles of cast iron pipe of 16 to 6 inches diameter, with 82 fire hydrants, 30 gates and 175 taps. They pays $100 per year for each hydrant, service pipes are of galvanized iron.

The population in 1880 was 11,437 and is now said to be 14,000. The capital stock of the company is $150,000. Nathan Shelton is President, and W. M. Flanagan, Supt., T. R. Sylvanus is Secretary and Treasurer.

DCX. FAYETTEVILLE, N. C.

Fayetteville, Cumberland County, North Carolina, in lat. 34° 2′ N. long. 79° 6′ W. is on the Cape Fear River at the head of navigation. It was settled about 1750.

Water-works were built by a private company, about 1825, taking the supply from a spring 30 feet above the general level of the town, and distributing the water by pipes of bored logs. Some of the original pipe are still in use. The works were leased in 1875 by S. W. Tillinghast, and were then in rather a dilapidated condition, and not much has been done to them since. There are two miles of 3 inches wooden pipe, on which hydrants are placed in the streets and kept locked, each consumer having a key. For fire service there are cisterns under the streets. No records of the management have been kept. The capital stock of the company is $2500. The number of consumers is not given. The population in 1880 was 3,485.

DCXI. EDMORE, MICH.

Edmore, Montcalm County, Michigan, in lat. 44° N. long. 84° W. is on the divide between the water sheds of Lakes Huron and Michigan.

It was settled and incorporated in 1878. Water-works were built by the village in 1881, after plans of James Slemons, taking the supply from a well 16 feet square and 31 feet deep, and ten 2 inch tube wells driven 50 feet.

The water is pumped by two Dean Brothers steam pumps, of 10 inch steam and 6 inch water cylinders of 12 inch stroke, delivering into a reservoir 31 feet in diameter and 11 feet deep, with 8 inch brick sides and 6 inch thick bottom on 2 feet of concrete, at 40 feet above the pumps and 20 feet above the village. The pumps can also deliver into the mains with 150 lbs. fire pressure.

Distribution is by one mile of 3 and 3½ inch wrought iron pipe with 8 fire hydrants, 2 gates and 25 taps. Service pipes are of wrought iron. The population in 1880 was 900, and is now said to be 1,500. The daily consumption is 8,000 gallons. The works cost $8,500. There is no debt. The expenses in 1883 were $500, and the receipts $350.

The works are managed by the fire committee of the village council. James Slemons in the Superintendent and Engineer.

WATER.

PITTSFIELD, N. H., has voted to put in 26 hydrants for use in connection with the Fire Department.

THE Gloucester N. J. Water-works system was tested this week.

BELLEFONTE, Pa., takes its name from a spring called "Bellefontaine," situated near the centre of the town, which is said to throw 14,600 gallons of water in a minute.

THE Bancroft Dam, at South Peabody, Mass., was destroyed on March 20. Damage $1,500.

Two of the reservoir dams on Beaver Brook, near Ansonia, Conn., were carried away on March 26, liberating about 50,000,000 gallons of water, and doing damage to the extent of $250,000. Two highway bridges, and the Naugatuck R. R. bridges are reported destroyed.

THE dam of the Newport (R. I.) Water-works at Lawton's Valley broke on March 26, doing considerable damage.

The N. Y. Fire Board want to paint the street hydrants bright red.

THE city of Manchester, England, now has water reservoirs covering 844 acres, whose mains measure 643 miles and they supply 20,000,000 gallons to 900,000 people daily. The cost thus far has been £3,352,000.

RED BANK, N. J., approved on March 24, by a popular vote, the issue of bonds for the construction of water-works. Three water commissioners are to be at once appointed.

THE Seventh Annual Report of the Lambertville N. J. Water Co., has been received. Total revenue $2,711.50, total expenditures, $1,304.33.

THE Annual reports for 1883 of the Water Commissioners of Plymouth, Mass. has been received. Daily consumption, 485,151 gallons; annual income, $13,486.93; general expenses, and extension, $10,508.18.

THE Mass. Legislature has now under consideration two bills relating to water meters. Bill No. 1, relates to the testing and regulating of meters, and proposes the appointment of a State Board on Water Meters. Bill No. 2, provides penalties for any local board or commission which may become pecuniarily interested in a meter or any of its appurtances.

BEFORE the Senate Committee of Investigation, last week, George W. Birdsall, assistant engineer on the Croton Aqueduct, testified that water meters were placed in buildings used for business purposes at the expense of the owners. In private houses they were placed at the expense of the city. Only about twenty-five meters have been put in private houses. Meters were put in buildings used for tailor shops and like purposes because such buildings had closets. The department had the right to put a meter in any place except private houses. Inspectors report what buildings require meters. About seventy-five per cent. of the places reported as requiring meters had been actually "metered."

THE Boston Water Board has awarded the contract for furnishing iron castings to Osgood & Hart, of the Everett and Lowell Foundry, for $8540. There were five other bids, the highest of which was $10,430. The contract for brass and composition castings was awarded by the board to the Boston Machine Manufacturing Company of this city. The contract requires the delivery of about 5000 pounds of bras castings and about 15,000 pounds of composition castings, the net amount of the bids for which were as follows: Mowry & Phillips of Cambridge, $1919; Joseph F. Ross of No. 50 Broad street, this city, $1568; Stephen Anderson of Cambridge, $1317, and the Boston Machine Company, $1311. The latter bidder offers to furnish the brass castings at 17 cents per pound, and the composition castings at 19 cents per pound, and to take from the city 15,500 pounds of old brass and composition castings and about 3400 pounds of brass turnings, etc., and to pay 13 cents per pound for the former and 11 cents per pound for the latter.

THE Mount Vernon, N. Y. Water Company after a thorough test of their artesian well are now erecting a powerful Knowles steam pump, and expect to be in operation at an early date.

CHARLOTTEVILLE, Va., will build Water Works.

AGAINST WHISKEY AND WATER.—CANTON CITY, March 17.—For once the temperance people are in a curious position—for Prohibition and against the water bonds—against both whiskey and water. A mass meeting of citizens was held at the Court house Saturday afternoon and nominated a strong ticket for Town Board at the spring election, all Prohibition men so far as known, and a very hard ticket to beat. The question on which this election will turn, however, is that of voting $60,000 in bonds to buy the plant of the water company. It is estimated that this is a fair price for the plant and is argued that the purchase would be a good thing for the city.

NEWTON, PA., Mar. 17.—Work on our water works is progressing rapidly. Much of the material is on the ground and the contractors declare that they will have water running through the mains within sixty days. The system will cost about $90,000. It will be the first in the state for a town of the size of Newton.

BORING FOR WATER AT GREELEY.—GREELEY, March 17.—J. C. Swann & C., the artesian well men, have drilled 1,440 feet. A small quantity of fish oil has been struck and a flow of water at 1,170 feet. It was decided to case with 6-inch casing to a depth of 1,225 feet, to shut off the flow and to enable the drillers to go on with their work. Accordingly, reaming was commenced. The reamer unscrewed and was lost at 700 feet last Tuesday. It was recovered yesterday, after fishing nearly a week. There is no similar drilling elsewhere in the State, 1,375 feet being silicate slate. The casing is expected from Pittsburg this week. The expenses of this well will be great, but the citizens are bound to test the matter fully.

J. B. FAIRBANKS is the newly elected Water Commissioner of Natick, Mass.

FILTERING THE WATER SUPPLY.—Mr. W. A. Collord delivered an address, Tuesday the 11th, before the Engineering Section of the Mechanics' Institute, Cincinnati, on "Artificial and Natural Filters for the Water Supply of Cities." After describing the great artificial filtering systems of the English cities, he explained the natural filters in use at Lyons, Toulouse, Genoa, Perth, Newark (N. J.) and Brooklyn, of which the most successful is that of Genoa. Through every bed of sand or gravel adjoining a river, or sand-bar in its bed, there is a slow circulation of naturally purified water The current is strongest near the bed-rock. Walled and arched galleries are driven through such a bed of gravel or sand below the level of low water, and the water wells up from the uncovered bottom, or through the perforated sides, and is pumped up into supply basins. Mr. Collord suggested as a substitute for use here a number of perforated cast-iron cylinders, sunk in a convenient sand-bar, each connected with the influx mains, and surrounded by concentric rings of broken stone, coarse and fine gravel.

POTTSVILLE, PA., March 17.—The Girard Trust representatives here to-day gave out a contract for the construction of an immense reservoir. The dam will be located at Lost Creek, and is intended to supply the collieries in that section, which, for years past, have suffered seriously from the Summer drought. The appropriation is $15,000, but the bid of Colonel Thomas H. Rickert, to whom the contract was awarded, was somewhat less. The breast of the dam will be forty-two feet high and 150 feet long, backing up water over eighteen acres of land, and calculated to hold 87,000,000 gallons of water.

THE present year is the last under the contract by which Salem, Mass., is to furnish Beverly with water for the round sum of $11,000. It is felt by many people in Salem, conversant with the matter, that the price is not equitable and just in consideration of the fact that Beverly has about as many miles of pipe as Salem, though perhaps the number of services is not as many, and throughout the stretch of north shore, from the foot of Washington street in Beverly to the Manchester line, on all the large estates of the summer residents, lawn fountains supplied by Wenham water are kept running often night and day, week in and week out, and the faucet in the yard is not often promptly shut after the carriage or the harness is washed. The present price is fixed by the Supreme Court, and at the close of the present year the Salem Water Board will send in a communication to the City Council asking for a new arrangement of prices. The question of a new water main has become very prominent the past week. By the way of Danvers and Peabody via the road passing the rendering works, which is the plan proposed, the total distance is 38,500 feet, and the cost, it is believed, would be from $250,000 to $300,000, which at the present time could be funded at 3½ to 4 per cent. This route, it is claimed, is preferable, because the twenty-inch main would come into Boston street and there connect with the twelve-inch main. The distance via Danvers and North Salem would be about 30,000 feet, or more than a mile shorter than the other route, but the North street main is a six-inch instead of twelve; still it is believed that even if the twenty-inch main were continued to Mason street on North, the cost would be less than by the extended route through Peabody. Whatever is done an act of Legislature will probably be necessary, and it is therefore not believed that the present City Council could do more than to put matters in shape for petitioning the Legislature of next year for an act to authorize an additional main.—Boston *Journal*.

NEW WATER GAUGE, FORT COLLINS, March 13th.—State Engineer Nettleton came up from Denver last night, and to-morrow he will superintend arranging in place the instrument lately invented by him for recording the rise and fall in the Cache la Poudre river. The machine is an exceedingly simple one in point of construction, but marvelously accurate and perfect in doing its work. The Poudre valley country is at the present time the most productive, in an agricultural sense, of any in the State, and the demands on the Poudre river are heavier than on any other stream. This being the fact, the State Engineer has given the gauging of water in that stream much attention. He has invented an instrument that is almost human in its work, and to-morow it will be put to work on the river up in the canon, above the point where the water of the ditches is taken from the stream. The instrument is about the size of an ordinary sewing machine, and will be run by clock work, which E. W. Reed is at the present time constructing.

The machine will occupy a small house on the bank of the stream, and will be wound up once each week. By it the rise and fall of water in the river will be recorded to one-tenth of an inch, and to the very minute of a day in the week. The instrument consists of a cylinder, which makes one revolution a week. On this cylinder ruled paper is attached, with each day marked off, and lines through that day indicating feet and inches. A float placed in a reservoir in which the water will always be the same height as the stream, either rising or falling it turns a wheel on which it is balanced. This wheel moves a pencil either backward or forward across the cylinder, marking the number of feet by rise or fall when going along it and the time of day when going around it. At the end of the week the paper is taken off and there is a picture of the river for the week. It will be seen, for instance, that at 12 o'clock Saturday it was four feet six inches high, and at 25 minutes past 2 on Sunday morning it began to fall, and so on. This machine with the other which the engineer has invented for measuring the velocity of the water will enable him to learn the capacity of the streams, and give every man his fair share.—Denver *Tribune*.

WAHPETON, Dakota proposes to invest $20,000 in water works.

A CONTRACT for 350 tons of six-inch water-pipe at $33.10 per ton and 250 tons of eight-inch water-pipe at $33.80 per ton, was awarded to the Cincinnati & Newport Iron & Pipe Company, by the village of Hyde Park, Ills.

IT was voted at the Nahant town meeting to defer the issuing of bonds for $65,000 to defray the expense of purchasing and laying water pipes until June 2.

JACOB HALBACH, the Republican nominee for Superintendent of Water-works of Lancaster, Pa., will probably be elected.

Messrs. GOODHUE & BIRNIE, well-known Water Works Contractors, of Springfield, Mass., have taken the contract for Hudson, Mass, Water Works. Price complete, $66,000; gravity supply; eight miles of pipe, 6 to 14 inches diameter, to be wrought-iron, cement lined. To be completed by Sept. 1st.

GRAND FORKS, Dakota, will expend $15,000 this year in extending its water works system.

PITTSBURG, Kan., is figuring on the cost of water works for the city.

NEWS OF THE WEEK.

Railroads, and Canals.

THE Governor of Mass. has signed the Meigs Elevated Railroad bill.

HOLYOKE, Mass. is to have a new horse railroad of two miles length.

NEARLY five hundred employés of the Pennsylvania Road, not able to pass an examination for color blindness, deafness, etc., have been suspended, and the examination still goes on.

THE St. Croix & Chippewa Falls Railway Company, composed of Wisconsin Central officials, is to construct a line from Chippewa Falls to the western border of Wisconsin on the St. Croix River, a distance of eighty miles. This is the Central's new line to St. Paul.

A PRELIMINARY reconnaisance of both the upper and lower routes for the proposed extension of the Boston and Lowel R. R. from Lawrence to Haverhill (9 miles) has recently been made. Both lines pass the site of the proposed dam at Mitchell's Falls. It is expected that the road will be built to Haverhill within a year, with the possibility of future extension down river to East Haverhill, Merrimacport and Amesbury.

THE canal which is to connect the Gulf of Athens with the Lepanto is 7,600 metres in length, 8 metres in width, and 2.35 metres in depth. There are two dredgers employed on the work, each of which can excavate 5,000 cubic meters of material in a day of 10 hours. The buckets of these machines have each a capacity of 750 litres, and a compound engines of 300-horse power raises 14 of these buckets every minute. M. de Lesseps, at a trial of one of these dredgers, was astonished at the quantity of work performed.

CARLINVILLE, Ill., March 18.—The Burlington & Ohio River Road was sold at public auction by the Master in Chancery to-day to H. S. Hopkins, of St. Louis. The amount of his bid was $13,700. The road was graded for thirty-five miles, and all the piling and bridge work finished, including nearly four miles of steel rails. There was expended about $200,000 in the construction of the road up to the time of its collapse. The property is in fair condition and is a good bargain, and the syndicate purchasing it will build to Carlinville within the next four months.

LAYING the second track of the New York and New England R. R. is progressing favorably.

THE Brighton Road (England) Electric Railway Extension will be opened this month. The short experimental line was operated from Aug. 2, 1883, to Jan. 4, and in that time carried 30,000 passengers. The gauge is 2 feet, a Siemens motor run by a 2-horse power. Otto-gas engine supplies the power. The track is to be relaid with a 2 ft. 9 in. gauge

THE Charing Cross and Waterloo Electric road is under construction. The Capital is £100,000; the road passes under the Thames by a tunnel now being dug. A third company, with a capital of £500,000, has laid out four new routes for Electric railroads through London.

THE second track which the Grand Trunk Railroad Company propose to build between Toronto and Montreal will, it is estimated cost about $6,000,000.

AN elegant little folder printed in black and gold, and entitled "Gold," has just been issued by the Northern Pacific, describing the Cœur d'Alene mines.

THE contract for the rock work on the mountain division of the Canadian Pacific, near Kicking Horse Pass, was let to Brady & Hubbell for $1,000,000 in the aggregate. Other contracts were let to Murphy, Larson, and others, aggregating $500,000 more.

LEXINGTON, KY., March 24.—The work of track-laying on the Kentucky Union Railroad was begun at Medges Station, in Clark County, where that road branches off from the Chesapeake and Ohio. It is thought that the track will be laid and the road in running order to Clay City, a distance of twenty-three miles from Hedges, within a month.

IT is proposed to construct a railroad and telegraph line, called the Colorado Springs through the Ute pass into the South park, to Salida and Leadville, with a branch down the Trout Creek valley to the junction of the South Platte river.

CONSTANTINOPLE, March 26.—A man by the name of Zelcon, who was at one time the American consular agent in Alexandria, has asked the Porte for a concession to build a ship railway from El Arich to Akabah, so as to unite the Mediterranean with the Red Sea. The distance in a straight line is about 130 miles.

OTTAWA, March 22.—In the house of Commons, Sir Charles Tupper's resolutions respecting the arrangements with British Columbia for the construction of the Nanaimo and Esquimault Railway was adopted and a bill to carry it into effect was adopted.

THE Directors of the Rome, Watertown and Ogdensburg Railroad Company, at their last quarterly meeting decided to build at once the Norwood and Montreal Railroad, a short line between Norwood and Massena Springs. The purchase of 3000 tons of steel rails was ordered, which, when laid, will make a total of 13,000 tons placed upon the main line during the present fiscal year.

THE annual report of the Flint and Pere Marquette Railroad Company shows that the total earnings of the road during 1883 were $2,542,943,64; operating expenses and taxes, $1,735,517; net earnings, $807,426. The funded debt of the road is $5,197,000. The report shows a net increase of a fraction over 10 per cent, over the previous year. The road handled 1,393,150 tons of freight and carried 1,048,496 passengers during the year. The income was earned on 246 miles of road, all of which is steel rail. The total earnings for 1882 were $2,165,219.

SPLIT AND STUB SWITCHES.—There are numerous styles of switches, but these are divided into two classes, viz., the split and the stub switch. The novice can determine whether the switch that he has just passed is a stub or a split. If it is the former the car will jolt and jump, and the switch will herald its presence with a great racket, while the presence of the latter will be scarcely perceptible. If the stub switch is set wrong the engine will be derailed, while the worst that can be done by a blunder in handling the split switch is to send the train off on the side track. At a recent meeting in Chicago, Chief Engineer Latimer, of the N. Y., P. & O. road, condemned a certain pattern of the stub switch, whereupon an official of the Pennsylvania line, thinking to silence him, said that the Pennsylvania road was using them. To a Pennsylvania official the

mere assertion that his road is using a particular article is deemed equivalent to saying that no further questions as to its efficacy need be asked. Mr. Latimer horrified the official by suggesting that the Penn. road was not infallible. Since that time the road has been taking out those switches upon which it had set its seal of approval. The question naturally suggests itself, "If split are so much superior to stub switches, why do not all roads adopt them?" The answer is simple; because they cost, on an average, about $40 more than the stub variety. *Cleveland Herald.*

THE Norfolk & Western R. R. earnings in February 1884, were $13,008 above those of the same month in 1883.

THE passenger department of the Michigan Central Railroad has issued an elaborate and handsomely designed calendar, advertising "The Niagara Falls Route." It is one of the most elegant things of the kind extant.

THE water gas works of the Citizens' Steam Heating and Gas Company in Lynn, Mass., are turning out 135,000 feet of gas per day, which is sold at 50 cents per 1000 feet. The works can produce 500,000 feet. Prof. Lowe has the utmost confidence in the success of the gas. One hundred purchasers in Lynn are using the gas for heating purposes.

THE Huntingdon railway system in Guatemala and San Salvador will, when finished, aggregate over 600 miles of track, and will cost some $8,000,000. The three-feet-six guage has been adopted. The principal cities of San Salvador and Guatemala will thus be in rail communication with each other as well as with either coast.

Mr. Ramon G. Guzman, one of the leading bankers and merchants of Mexico, died in Mexico, Feb, 25. Mr. Guzman obtained the Mexican Central Railroad concession, and was the attorney and one of the local directors of the company. He was also the principal owner of the street railways of the city of Mexico, and was, altogether, interested in more enterprises in Mexico than any other man.

B. F. LA RUE, City Engineer of Jackson, Mich., has just completed the preliminary survey of a railroad line from Mason to Dexter and has been able to find a very good route indeed. The profile shows very easy work and the alignment is exceedingly good. The distance is a little less than 36 miles, which would make the distance from Detroit to Lansing on the Michigan Central about 16 miles shorter than via Jackson.

THE Detroit, Lansing & Northern R. R. have completed their new shops, from the plans and under the superintendence of the Chief Engineer, J. J. McVean. The round-house is 250 ft. diameter, with 20 stalls; adjoining it are two water tanks of 52,000 gallons each. The machine shop is 110 × 250 ft. and 57 ft. high; the car-shop is 80 × 280 ft., and between these two buildings is a transfer table, with pit 60 × 220 ft. The store-house is 20 × 100 ft., the boiler-house 47 × 47 ft., with stack 102 ft. high, with 5 × 5 flue. All of the buildings are built of brick, handsome in design, and with slate roofs. A 30-in. sewer drains the shops, and the works are provided with a water supply of their own, the pumps having a 6-in. supply and 5-in. discharge pipe. Collins & Jaynes of Detroit, were the builders, at $111,459.80. A wood working shop, 70 × 140, is yet to be built.

ACCORDING to recent reports regarding the Northern railroad of Guatemala three parties of engineers have commenced the survey of this road, and the directors intend, when the first party, headed by Mr. S. Miller, the chief engineer, completes the survey of the section from the port of Santo Tomas to El Mico, a distance of sixty-five miles, to begin work at Santo Tomas and push the grading as rapidly as possible. General F. Millen has obtained the contract for all the work on the first division, and all the necessary implements have been ordered at New York and will be shipped to Santo Tomas. The survey from Santo Tomas to El Mico will soon be finished, and the president of the company writes that the construction of the road would commence at Santo Tomas about February 1. The place for the iron wharf at the later port has been located and will soon be built.

THE contract for building the New York, Norfolk & Charleston R. R. has been let to the Carolina Construction Co., including the entire equipment, rolling stock &c., The Construction Co., has sublet the building of the road-bed, grading, bridges, stations, round-houses and work shops to the American Contracting Co., of New York, for the sum of $3,101,171 in bonds and stock of the Company. The road is to begin at Norfolk or Portsmouth Va., and extend to Charleston, 330 miles. It is to connect by a transfer boat across Chesapeake Bay with the line now building by the Pennsylvania Co., down the Peninsula. A saving of 180 miles in distance and seven hours in time will be effected over existing routes.

ARTICLES of incorporation were filed in the County Clerk's office of New York, Mar, 25. of the United States Cab e Road and Subway Company, with a capital stock of $250,000, in 10,000 shares of $25 each. The objects of the company are stated to be" the securing, development, adaptation, and application of such mechanical devices as may be useful, necessary, or proper in the construction or operation of cable roads, either above, upon or below the surface of streets, highways, or other road beds * * * either directly or by licensing their use." The Trustees of the company for the first year are Frank B. Knight, Scott Lord, Bradford D. Bradley, John Cornwall, William A. Walker, O. D. Orvis, and Nelson B. Adams.

A COMPANY is applying to the Dominion Parliament for a charter for the Great Northern Railway, to run from Ottawa to Quebec. The road is to run at a distance of from 20 to 30 miles north of the North Shore Railway. The length of the road will be about 138 miles, and it is expected that it can be built at a cost of about $20,000 per mile.

It is proposed to construct a line from the western terminal line of this railway to join the Ontario and Quebec Railway at Perth, thus giving Quebec almost an air line to Toronto and thence to Chicago. The people of Quebec are confident that this scheme will procure them the terminus of the Canadian Pacific Railway.

THE RIDEAU CANAL.—On Friday last several prominent gentlemen from Kingston and other places waited upon the Minister of Railways and Canals at Ottawa, in reference to a proposed extension of the Rideau Canal. The cost of the work will be about $100,000, but the advantages to be derived from this outlay are said to be almost incalculable. Among some of the benefits that would follow might be mentioned that some 150 square miles of land would be materially increased in value, a considerable area of land now drowned would be reclaimed, some 500 miles of coast line would be made accessible to navigation; some 50,000 acres of land, well-wooded and rich in iron and phosphate mines, would be brought within reach of a market. It was also pointed out that the waters of the canal are yearly getting lower and new feeders must in any case soon be provided, and the proposed scheme would attain that end as the lakes in question are deep. It was also shown that the scheme of a canal from Morton *via* Charleston Lake to Gananoque, in which the people of Leeds and Gananoque are deeply interested would thus be made practicable. The deputation was most courteously received, its representations carefully listened to, and the Minister promised that the matter would receive his earnest consideration.—Smiths' Falls, *Independent.*

Contracting Miscellany.

TROY, O., is to have a $150,000 Court House.

THE contract for the new Town Hall at Newcomerstown, Ohio, was awarded to Messrs. Criswell & Negley, contractors of New Philadelphia, O., for $19,450 complete.

THE plans of F. M. Ellis, of Marshalltown, Ia., have been secured for Brainerd, Min., $40,000 high school. The building will be built immediately.

PRESENT indications warrant the statement that there is to be an unusual amount of building in Burlington, Vt., during the present year One party has already entered into contract to build the foundations for thirty-five structures.

THE proprietor of the Glen Quarry in Mason has a $100,000 contract for furnishing stone to go to Fall River, Mass. Over 100 men will be immediately employed, cutting machines will be operated day and night, and electric lights will be introduced.

ON fourteen sections of the Panama Canal work is now being pushed forward actively. Four million cubic métres of earth have been removed within a few months. About 80,000,000 cubic métres in all are to be removed. Fifteen thousand men are employed on the work. They earn about $1 a day each, and spend about 20 cents a day for food.

THE contract for the rock work on the Mountain Division of the Canadian Pacific near Kicking Horse Pass was let March 7th to Brady & Hubbell for $1,000,000 in the aggregate. Other contracts were let to Murphy, Larson, and others aggregating half a million or more.

MUNROE Co., Penn., is to have a new court house, to cost $11,000.

CARROLLTON, O. is to have a new court house and jail. Frank O. Weary, of Akron, O., is appointed architect.

THE American dredge at Panama is doing good work; 6,600 cubic yards per day is the average output. The second dredge will be ready in five or six weeks.

BOSTON, March 21.—Augustus Whitemore and J. B. Richardson were appointed receivers of the Midland Improvement and Construction Company. The corporation was formed four years ago to undertake the construction and equipment of railroads, with a capital stock of $500,000.

ORDINARY Chicago brick has advanced in price from $7.75 per 1000 last fall, to $10. The present demand is great and the supply moderate. $2,000,000 is said to be invested in 55 brick yards in that city, and the high price will only be temporary.

THE Treasury Department has awarded to Bartlett, Hayward & Co., of Baltimore, Ind., for $11,600 the contract for furnishing and putting in place the cast-iron columns and rolled iron beams for the Custom House and Post Office, at Toledo, O.

PITTSBURG, Penn., March 15.—An order was granted today in the United States court in the suit of the New Castle Northern Railroad Company against T. P. Simpson, a New York contractor, modifying the injunction heretofore granted against the defendant so far as to allow him to proceed with the work of construction and performance of the covenants under the contract; but so far as it restrains any proceedings under the arbitration clause it is allowed to stand as originally issued.

NEW ORLEANS. March 12,—On January 5, Fletcher, Wesenberg & Co. filed a suit against the North-eastern Railroad Company, claiming $261,000 as the balance due on a contract for constructing a trestle and bridge across Lake Pontchartrain. The railroad company filed an answer to-day denying any indebtedness to the firm. On the contrary, it avers that Fletcher, Wesenberg & Co., are indebted to the railroad company in the sum $350,000 to recover which the company brings a reconventional demand, in which it asks for a judgement against the contractors for the full sum, and the dismissal of the contractor's alleged claim against the railroad company.

BATAVIA, N. Y., March 20.—Edward F. and Harry E. Lathrop, in the Circuit Court, to-day obtained a verdict for $8,334 against Jonas J. Blake & Brother. The plaintiffs were subcontractors under the defendants in building a mile of the Vanderbilt and McGee Jersey Shore, Pine Creek and Buffalo Railroad in Pennsylvania during the Summer of 1882. The new road was built from Jersey Shore to Stokesdale, Penn., and was an extension of the Fall Brook Company Road to furnish the New York Central with hard coal. The plaintiffs' mile of road was hard to work, 800 feet of it being solid rock, and the centre cut ranging from 10 feet to 35 feet. They disputed the measurements and figures of the civil engineer, claiming to have taken out nearly 20,000 yards of earth more than they were allowed for, and accordingly they brought suit.

Bridges.

BRIDGING NAVIGABLE RIVERS.—The house committee on commerce has ordered a favorable report on the bill allowing persons or corporations to erect a bridge across any navigable river of the United States, or between the United States and any foreign country, provided free navigation is not materially injured.

THE Keystone Bridge Co., holds the unfinished bridge across the Ohio at Point Pleasant, W. Va., of the Ohio Central Co., until payment is secured.

THE plan for the bridge across the St. Lawrence River for the Ottawa, Waddington & New York R. R., has just been adopted by the Dominion Privy Council.

AT a meeting of the Trustees of the Brooklyn Bridge, on March 26, the following resolution was offered and carried after some opposition; *Resolved*, That the bridge be completed and an avenue of approach to the bridge be opened over Chatham and Centre streets to the Hall of Records, and on the same elevation as the tracks of the railroad on the bridge at Chatham and Centre streets. The structure shall span Chatham and Centre streets by suitable length for passage under the same for all purposes of public travel and transportation.

THE trestle bridges on the Barre R. R. Vt., at Barre Junction, have been for a third time destroyed by ice.

THE Naugatuck R. R. bridge over Beaver Brook, between Ansonia and Derby, Conn., was destroyed by a flood on March 26.

Streets, Drainage, Sewerage, Etc.

CONTRACTS for Cedar Block paving in Toronto, Can., to the amount of $110,000 were let last week.

MANSFIELD, O., may borrow $39,000 for sewerage purposes.

THE Salem, Mass., sewer if built will cost over $60,000. Length 10,000 feet.

THE Atlantic City, N. J. Drainage Company have resumed work and expect to complete their system and have it in successful operation by the 1st of July.

WOODEN pavement is in marked disfavor in Berlin. What is known as Vienna head pavement is taking its place. The wooden article laid down in the neighborhood of the Crown Prince's palace has failed after a short year of trial.

A SPECIAL borough meeting, held last week at Stamford, Conn., for the purpose of voting upon a system of sewerage which had been recommended by the Warden and Burgesses, and on the question of bonding the borough for $100,000, was the most exciting ever held there. The Town Hall was packed. Finally a motion for indefinite postponement was carried by a vote of 144 to 79, not half of those present voting. The result was a great disappointment to some leading citizens who want the own sewered

COUNCILS Highway Committee of Phila. met on the 24th in the office of the Chief Commissioner in the new Public Buildings, and opened and scheduled bids for various contracts and supplies. The lowest bidder for the building of an intercepting sewer in Fairmount Park was John J. Kennedy, at $9.49 per foot; for sewer at Rock Tunnel, J. J. Kennedy, $32.91 per foot; for sewer from Rock Tunnel Northwest, N. B. M. Conklin, $12.47 per foot.

The bids for repairing South Street Bridge were: James Armstrong, $105,000; Childs & Conklin, $81,920; Clark, Reeves & Co., $107,000; for repairing Chestnut Street Bridge, R. J. & R. B. Malone, $58,000; Anderson & Barr, Little Rock, Ark., $53,000. The bidder for coal for the department was J. S. Cross, $6.75 per ton. The lowest bidders for grading were N. B. M. Conklin and Daniel Mooney, each 23 cents per yard; for furnishing curbstones, Daniel Mooney, 65 cents per foot; for new granite curbing, B. McNichol, $1.40 per foot; for laying brick payments, N. B. M. Conklin, 52 cents per yard. The name of H. J. Becker was removed from the contractors' blacklist.

THE contract for constructing a part of the Gillis street public sewer was let yesterday by the city engineer in the presence of Aldermen Patterson, Sweet, and Regan, to H. B. Alexander at $13,274.50. The other bidders were William H. Faulkner, $15,835.50, and John Shaw, $14,270. The contract calls for 775 lineal feet of four foot two inch brick sewer; 330 lineal feet of four foot six inch brick sewer, eight catch basins, seven man-holes, twenty-five cubic yards of concrete, 1,000 feet of lumber, 100 feet four inch agricultural sewer pipe. The contract was let subject to additional appropriations. The sum of $6,000 was appropriated at a recent meeting of the council, and the work will be proceeded with to the extent of $6,000, and an additional appropriation then obtained.—Kanas City, *Times*, 23.

THE question of sewerage is exciting active discussion in Kingston, N. Y.

Gas and Electricity.

RICHMOND, VA., has a Board of Public Interests, which has just reported upon an investigation of the Gas Department; among other items they give the following as the cost of gas in that city, as reported by the department:

Cost of distribution, manufacture and extension of mains for eleven months, ending December 31, 1883, $1.03 9-10 per 1,000 cubic feet.

Cost of gas in the holder in November, 1883, 59c. per 1,000 cubic feet.

Cost of gas in holder in December, 1883, 55 95-100c. per 1,000 cubic feet.

Cost of gas at the burner in November, 1883, 70c. per 1,000 cubic feet.

Cost of gas at the burner in December, 1883, 65 94-100 per 1,000 cubic feet.

Cost of gas in the holder for eleven months ending December 31, 1883, 66c. per 1,000 cubic feet.

Cost of gas at the burner for eleven months, ending December 31, 1883, 93c. per 1,000 cubic feet.

The Board state that in the above statement the interest on the plant is omitted; adding the interest on $1,150,000, the cost of the works, to the above, with 107,009,820 cubic feet made, would result in $1.63 per 1,000 cubic feet as a more correct figure of total cost.

THE Brush Electric Light Company have been making experiments with electric motors at Cleveland, and a railroad has been built for the purpose of testing the motors for tram cars.

AN ordinance granting a franchise to the Western Edison Electric Light Company to lay a system of underground electric conductors in the village of Hyde Park, Ill., was engrossed.

EDISON, the inventor indulges in the following prediction: As to the changes which will be effected by electricity within fifty years in the city of New York, I would say that I believe electricity will propel the cars of the street and elevated railroads, light the city within and without its buildings, furnish power for all purposes, work telephones and burglar alarms, deliver the opera, convey parcels, detect and signal fires, operate fire engines and possibly displace animal locomotion for vehicles.

THE high cost of lighting the city by electricity has furnished the Aldermanic Committee on Lamps, who have been investigating the subjects with an incentive to inaugurate a better and more general lighting by gas. It is said that when the electric light companies' contracts expire, in April next, the number of electric lights will be reduced perhaps one-half, and the number of large gas-lights will be increased. The electric light companies manifest little inclination to reduce their rates, while some of the gas companies are willing to make concessions. The committee will seek to give the city better light at a reduced cost.—*Boston Commonwealth*, March 15.

THE Philadelphia Councils Committee on Water-works opened the following bids for Electric Light Plant, and other supplies. For Electric Lighting Plant for Spring Garden Station—U. S. Electric Lighting Company of Pennsylvania, one plant, complete, running any number of incandescent light from 1 to 200, for $4,460.50, or two plants complete, one running 1 to 110 lights, and the other 1 to 65 lights both for $6,218.90; The Edison Company for isolated lighting, one plant, complete, and 175 lamps of 16 candle power to last 600 hours, for $5,636, or two separate plants, with 110 and 65 lamps, respectively, for $6,176, or instead thereof, the said lamps to be equally divided between the engines and appliances at the same price, or will furnish 1 engine and 2 equal dynamos with 175 lamps, for $5,935.

But one proposal was received for the two steel boilers for the Spring Garden Station that of the Edgemoor Iron Company at $13,025.

SIEGMUND T. MEYER, Asher T. Meyer, Charles C. Peck, William H. Chapman, and Philip L. Meyer are the corporators of the Chapman Electric Motor Company, whose certificate of incorporation was filed in the County Clerk's office last week. The new company is to acquire legal title to certain letter patents for improvements in electric motors, electric generators, electro-magnetic apparatus, commutators; to build such apparatus and apply them to all the uses to which they are suited, or to license others so to apply them. The capital stock is fixed at $500,000. The company proposes to manufacture an electric motor for which patents have been obtained by William H. Chapman. It differs from other motors in that the armatures are brought into a close contact with the magnet. The motors are to be light; one that will draw a car will weigh only 150 pounds. "The cross-town routes laid out by the Rapid Transit Commissioners would be especially adapted to the use of such motors" said an interested incorporator recently. A factory will probably be built in East Thirteenth-street.

Articles of incorporation of the Globe Electric and Underground Conduit Company have also been filed. The company is to manufacture, buy, and sell electrical conductors and to construct underground conduits for electrical purposes. Its capital stock is $2,000,000, divided into 200,000 shares of $10, each. Its incorporators are J. Clayton Erb and William D. Neilson, of Philadelphia, and J. Morris Welch, George R. Cinnamond, and Charles Reynolds Logan, of this city.—*N. Y. Times*,

IRON, METAL AND COAL MARKETS.

PHILADELPHIA, Mar. 27, 1884.

Transactions in Iron and Steel have not been of large proportions this week, and prices show no improvement, but inquiry is more active, and consumers are providing for current requirements with a little more freedom; considerable sales of pig iron could be made, both of Northern and Southern makes, if concessions could be had; but prices are now down as low as they will go, and Southern makers especially, are holding very steadily to asking prices. No. 1 Foundry is quoted at $20@$21; supply is light, but demand is of moderate proportions; No. 2 is very dull at about $19; Gray Forge, $18, delivered for average makes of Northern and Southern Forge. Steel rails are quiet, and prices are weak; sales of over 75,000 tons have been made within the past 10 days in Eastern and Western mills, and there are inquiries in hand for about half that amount, which will probably develop into business within a week or two. $34 is the usual mill price paid, but some sales are said to have been made at $33.50, although this is denied by makers. As soon as mills run a little short of orders, $33@$33.50 will probably be accepted for the large orders which are waiting to be placed. Iron for engineering requirements has sold in small lots during the week, but the large business which has been in sight for some weeks, is still withheld; Angles have sold at $2.20; Beams and Channels, $3.50, subject to 12½ per cent. discount. Merchant Iron is in rather better request in small lots, but prices are weak, and no large orders have been placed. Old Rails would sell freely at $21.50@$22, but are held $1@50c. above. Muck Bars are quoted at $32@$33, but sell as low down as $31 at mill, for ordinary makes. There is a slightly better tone in the Iron trade, but spring demand is still kept back, and business is wholly of a retail character.

PITTSBURGH, Mar. 27, 1884.

Inside quotations for Iron and Steel in Western Pennsylvania are as follows: $35@$36 at mill for Steel rails, $23.50@$24 for Old rails, $32 for Muck Bars, $20@$21 for Bessemer Pig, $18@$20 for Foundry Irons, $17@$18 for Mill Iron, $2.50 for Nails, $20@$21 for Wrought Scrap, $1.70@$1.90 for Bar Iron. Business is still far below the expectations of sanguine manufacturers, but shows an improvement over previous weeks. Only small proportion of the mills are working full; Singer Nimick & Co. have enough orders ahead to keep them running steadily; Carnegies Structural Iron Mill is full of work, having enough to last for several weeks. The Forging Department of Painter & Son Mill is closed down; 268 men are thrown out of employment. The Third Pool miners continue working at the reduction, and the result has been that reductions have taken place in the other Pools. All the miners are not at work, but it is probable that the reduction will in all cases be accepted.

CHICAGO, Mar. 27, 1884.

The production of Bar Iron for the past few months has been extremely light, and stocks have run down to almost nothing, but prices have not improved, nor has demand increased as was expected. Very few mills are running double turn and though small lots of Bars are moving with some activity, the aggregate of business is small, and prices are without improvement. Common Iron is quoted at $1.90, and Refined at $2, with concessions obtainable on good orders. The demand for Structural and Tank Iron has been more active at unchanged prices. Merchant Steel is less active than it has been for a week or two past, although an improvement at this time was confidently expected. Steel Rails are dull at $36@$37; makers are unwilling to make the desired concessions, and railway builders are unwilling to order heavily at present asking prices. Southern Pig Irons are still in favor. Foreign Irons are scarce, but in less demand than would be expected, on account of the increasing substitution of the domestic production. The movement in Heavy Hardware and Railway Supplies has been better; prices for Barbed Wire are stiffer and demand is active: Builders Hardware, and Farming and Gardening Implements are in good request, and business is brisk. Tubes, Pipes and Fittings are dull and quiet;

COAL.

PHILADELPHIA, Mar. 27, 1884.

The Anthracite Coal trade is very dull at present, but now that Harbor prices have been announced, it is thought that a more active demand will be developed; City and Line prices will be announced on Friday of this week. The policy of the Anthracite Companies has not been announced as yet; it is probable, however, that a further restriction of production will be agreed upon, as even half time production is too heavy for the present market requirements, and full time output will be almost certain to result in a break in prices; but, on the other hand, the companies will lose heavily if they restrict their production any further; there are strong arguments in favor of both plans, and it is impossible to say which evil will be considered the less. Large contracts for Bituminous Coal have been already placed in Eastern and Lake Markets, and negotiations are now in progress, which will probably lead to the placing of others; inquiry from the South is becoming more active, and heavy shipments in that direction will soon be made. Western markets will take enormous supplies of Coal this season, but orders have not yet been placed, to any great extent. Port Richmond stocks are but little under 100,000 tons. The line trade is quite active, and will be more so after the announcement of prices. Anthracite reduction for last week reported, 459,000 tons. The Clearfield region is producing about 60,000 tons per week.